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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

NOVEMBER 16.

Swansea Technical College, Metallurgical Society:—General meeting at Swansea. "Pickling," Paper by W. H. R. Bird, M.A.

NOVEMBER 20.

Newcomen Society for the Study of the History of Engineering and Technology:—Annual general meeting in London.

Institute of British Foundrymen.

NOVEMBER 21.

Institute of British Foundrymen (London Section):—Visit to the works of Messrs. Kryn & Lahy (1928), Limited, at Letchworth.

NOVEMBER 22.

Birmingham, Coventry and West Midlands Branch:—Ordinary meeting at Birmingham. "The Mechanical Handling of Foundry Materials," Lecture by R. Spriggs.

Sheffield and District Section:—Ordinary meeting at Sheffield. "The Metallurgy and Production of Modern Grey Iron Castings," Paper by A. E. MacRae Smith.

Skilled Work or Skilled Worker?

It is commonly said by imperfectly-informed persons, whose views are based upon examples such as the Ford works, that skill is at a discount in modern industry, and that in no long time it will to all intents and purposes have vanished. This argument sounds very pretty and is useful to theorists of the type who delight in wholesale condemnation of our industrial and social system, but it is disproved by the facts. It is, of course, true that industry in general is moving in the direction of division of labour, intense specialisation, mass production, and scientific management, although the movement is in many places still so slow as to be almost indistinguishable. It is also true that if such a movement did involve the disappearance of industrial skill as we understand it, the result would be deplorable. What is actually happening, however, is not a disappearance of skill but a reorientation of it. If the complex modern machine requires less manning than its primitive predecessor, the manning that it does require must be a great deal more skilled. Further, in its manufacture it demands a great deal of very highly-skilled labour that was unknown in the earlier industrial days. Still more important is the great growth of the staff grades in industry, all of whom must rightly be called skilled. Clerks, draughtsmen, salesmen, the costing staff and the research staff, all these employ an enormous number of men in the modern industrial unit, and all these were unknown or practically unknown fifty years ago. A distinguished Manchester industrialist, who has made a study of this subject over a period of some years, has recently published some extremely interesting conclusions on the question. The most striking of these was that during the given period of years in which scientific management was introduced in the large plant with which he is connected there has been an actual and relative increase in the craftsman category of employees. This has been accompanied by a reduction in the unskilled and semi-skilled grades, for the reason given above, namely, that the modern machine only needs a few men in attendance but those few must be highly skilled. The interest of this subject lies largely in the light it throws on the vexed question of education and training for industry. It would seem that it is to-day less important to train a lad to do a given job with a high degree of skill than to train him to use his brain in adapting such skill as he does possess to whatever job comes along. In other words, the skill that modern industry requires is mental rather than manual, although this must not be taken to mean that intellectual training should take the place of industrial training. Founding has always been regarded as a highly-skilled craft, and rightly, and therefore there have not been lacking gloomy prophets who have seen in every step towards mechanisation another nail in the coffin of craft skill. The old type of skill that enabled a man to do one job all his life and do it supremely well may be losing some of its prestige, but in its place there is a growing demand for the type of skill that can tackle and control any one of a large range of jobs and bring it through to a successful conclusion. A contemporary has aptly expressed the position in this way: "Skill is not necesarily reduced in the aggregate but changed in direction."

Bridging a Gap.

The technically-organised foundrymen of Great Britain have since the war visited the United States, France, Germany, Belgium and Spain. There have been national conferences in London, Glasgow, Birmingham, Manchester, Sheffield, Leicester and Newcastle, and, in addition, there have been literally hundreds of local works visits. The drawback to be associated with the foreign visits is that insufficient people can travel, and with the annual conferences too many, whilst local visits are obviously of a restrictive character. We have on several occasions commented on the "studying tours" such as are organised by Continental technical colleges, and this movement, with suitable modifications, oriented to meet the necessities of the British business man has a definite place in the development of technical associations. The plan we propose is that there should be arranged a series of meetings between the various local branches of the Institute of British Foundrymen, to take the form of a long week-end and to be of a reciprocal character. For instance, of the ten Branches, five pairs could be established of which, in the first year of operation, one partner would act as host to its associate, with the object of being its guest the year following. The scheme, if accepted, would probably resolve itself into the guests arriving in the district to be visited on Thursday evening and spending all Friday and Saturday morning in visiting the local works. Then the evenings could be devoted to a discussion on the local foundry industry or, perhaps, an informal social gathering. The scheme commends itself as being one which can and would widen the interests of the members in both the Institute and the industry. There are but few technical associations in the country possessing such well-organised local sections and having these at hand, it seems appropriate to make full use of them for the ultimate benefit of the whole industry.

XUM

The British Cast Iron Research Association.

ANNUAL GENERAL MEETING AND LUNCHEON.

The British Cast Iron Research Association held its eighth Annual General Meeting, followed, as usual, by the Annual Luncheon, at the Hotel Cecil, in London, on Wednesday, November 6, 1929. Mr. W. Turner MacLellan, C.B.E., presided at the Annual General Meeting.

The Director and Secretary (Mr. J. G. Pearce, M.Sc., M.I.E.E.) read the notice convening the meeting.

Apologies for inability to be present were received from Mr. Arthur Henderson, M.P. (Secretary of State for Foreign Affairs), Mr. P. J. Hannon, M.P., Principal C. A. Edwards, Prof. Sir Harold Carpenter and Sir Alan Smith.

On the motion of Mr. W. B. Barker, seconded by Mr. V. C. Faulkner, the minutes of the previous annual general meeting were taken as read, and were duly signed.

The Annual Report Adopted.

The Chairman, moving the adoption of the eighth Annual Report of the Council and the Accounts as audited and certified by the Association's auditors for the year ending June 30, 1929, said that inasmuch as he had been asked to preside over the meeting at a moment's notice, he was not prepared to comment on the details of the Report, though he had read it carefully. In view of the fact, however, that he represented the only Indian company at present within the membership of the Association (The Bengal Iron Company, Limited), he gave some figures relating to the growth of the iron industry in India. About 25 years ago, he said, when he went to India to take up work in the iron trade there, the output of pig-iron was about 70,000 tons per annum; to-day it is over 1,000,000 tons per annum. The output of castings had also grown; he was unable to say exactly what was the total output of castings in India, but the output of his company's works had often averaged over 2,500 tons per week for many weeks on end during busy periods. At present, owing to the curtailment of the railway programme, it is not so great. A very striking fact, illustrative of the progress made in the production of pig-iron, was that his company's works, with four furnaces, were producing at present three-quarters of the total amount produced in Scotland with 80 furnaces before the great war. That great progress was due to the use of larger furnaces and increased blast, and also to the ores and the nature of the fuel used.

The resolution for the adoption of the Report and Accounts was seconded by Mr. G. A. Ure, and was carried unanimously, without discussion.

Re-Election of President.

Mr. H. B. Weeks, moving the re-election of Major-General Sir Philip A. M. Nash, K.C.M.G., C.B., as President of the Association, said that no words of his were necessary to commend Sir Philip's name to the members, and he had every confidence that they would re-elect Sir Philip unanimously. The resolution was seconded by Mr. E. R. Briggs, and carried unanimously, with acclamation.

Election of Vice-Presidents.

On the motion of Mr. C. Retallack, seconded by Mr. W. Jolley, the following were unanimously re-elected Vice-Presidents: Mr. A. W. Steven, J.P. (MacDowall, Steven & Company, Limited, Falkirk); Mr. W. Reavell, P.P.I.Mech.E. (Reavell & Company, Limited, Ipswich), and Mr. W. Turner MacLellan, C.B.E. (The Bengal Iron Company, Limited, London).

On the motion of Prof. T. Turner, seconded by Mr. F. J. Cook, the following were elected Vice-Presidents: Mr. John Craig, C.B.E. (David Colville & Sons, Limited, Glasgow), and Sir William Larke, K.B.E. (National Federation of Iron and Steel Manufacturers, London).

Thanks to Retiring Vice-President.

Mr. H. Field moved that the best thanks of the meeting be accorded to Mr. T. Donaldson, M.A. (the retiring Vice-President). Mr. W. H. Whitehouse seconded. The resolution was carried with acclamation.

Election of Honorary Members.

Dr. Walter Rosenhain, F.R.S., moved that the following gentlemen be elected Honorary Members of the Association: Professor D. Hanson, D.Sc. (Birmingham University), and Mr. W. J. Rees, B.Sc. (Sheffield University). Dr. Rosenhain added that he moved the resolution with particular pleasure, because, by coincidence, both these gentlemen had been members of the staff at the National Physical Laboratory, with which he himself was connected. Mr. H. B. Weeks, seconding, expressed the Association's indebtedness to Prof. Hanson and Mr. Rees, and said that in electing them honorary members it was conferring upon them the only degree it was capable of conferring. The resolution was carried with acclamation.

Re-Election of Council.

Mr. H. G. Sommerfield proposed that the following be re-elected Members of Council, and also took the opportunity to express appreciation of the work the Council had done during the past year: Mr. J. Arnott, A.I.C. (G. & J. Weir, Limited, Cathcart, Glasgow); Mr. A. J. Burn (Llanelly Foundry & Engineering Company, Limited, Llanelly); Mr. J. Cameron, J.P. (Cameron & Roberton, Limited, Kirkintilloch); Major C. Howl (Lee, Howl & Company, Limited, Tipton); Mr. J. Marshall (Staveley Coal & Iron Company, Limited, Chesterfield); Mr. W. B. Parker, F.I.C. (British Thomson-Houston Company, Limited, Rugby); Mr. R. O. Patterson (Smith, Patterson & Company, Limited, Blaydon-on-Tyne); Dr. W. Rosenhain, F.R.S. (National Physical Laboratory, Teddington); Mr. G. A. Ure, J.P. (Smith & Wellstood, Limited, Bonnybridge), and Mr. H. B. Weeks, F.I.C. (London).

The resolution was seconded by Mr. John Shaw and carried unanimously.

Election of New Members of Council.

Mr. T. Makemson, proposing the election of the following gentlemen to the Council, said they were all well known in the industry, and the confidence he hoped the members of the Association would repose in them would be well justified: Mr. H. C. Dews (Dewrance & Company, London); Mr. W. T. Griffiths, M.Sc. (The Mond Nickel Company, Limited, London); Mr. W. B. Lake, Esq. (Lake & Elliot, Limited); President of the Institute of British Foundrymen (Mr. Wesley Lambert, J. Stone & Company, Limited, London), and Mr. D. Wilkinson (The Austin Motor Company, Limited, Birmingham). The resolution was seconded by Mr. G. Roberts and was carried unanimously.

Election of Auditors.

Messrs. Poppleton & App'eby (accountants and auditors) were elected auditors to the Association for the ensuing year, at a remuneration of 20 guineas.

Thanks to Scientific Advisers and Chairman.

Mr. E. R. Briggs proposed a hearty vote of thanks to the Association's scientific advisers—Prof. J. H. Andrew, Prof. P. G. H. Boswell, Prof. Sir Harold Carpenter, Prof. C. H. Desch, Principal C. A. Edwards, Prof. D. Hanson, Dr. W. H. Hatfield, Sir William Larke, K.B.E., Dr. H. Moore, Mr. W. J. Rees, Dr. W. Rosenhain, Prof. F. C. Thompson and Emeritus Professor T. Turner. The Association was fortunate (added Mr. Briggs) in securing the services of these gentlemen as scientific advisers, and owed them a very deep debt of gratitude. Mr. W. H. Whitehouse seconded the vote of thanks, which was accorded with acclamation. A hearty vote of thanks was also accorded the Members of Council for their services to the Association during the past year. The Chairman responded on behalf of the Council.

Mr. H. B. Weeks expressed the thanks of the meeting to Mr. Turner MacLellan for having agreed at a moment's notice to preside, and for the able manner in which he had conducted the meeting. Mr. C. Retallack seconded. As one who had been connected with the Association since its inception, he said, he was very glad to learn of its great progress. Also, he was delighted to have another opportunity of meeting Mr. Turner MacLellan and of congratulating him upon having occupied the chair. The vote of thanks was carried with acclamation.

The Chairman briefly expressed his appreciation of the vote of thanks, and the meeting then closed.

The Annual Luncheon.

A distinguished company attended the Association's luncheon. The President was in the chair, and the principal guest was Dr. F. E. Smith, C.B., C.B.E., D.Sc., F.R.S. (Secretary, Department of Scientific and Industrial Research).

The loyal toast was proposed by the President and honoured with enthusiasm.

A letter was received from Sir John Dewrance, a Past-President of the Association, regretting extremely his inability to be present. At the same time, Sir John commented in his letter, upon the good progress the Association had made, as indicated by the Annual Report, and expressed the hope that this progress would be continued and increased in the future.

Contact with Industry.

The President, in his address, said there was no need for him to refer in any detail to the Annual Report, but they would agree that it formed a record of very decided progress during the year. In his address a year ago he had visualised the work and services of the Association as they might be if not restricted in any way by financial considerations. During the year under review the Association had taken a further step towards that ideal development. The services which it placed at the disposal of members were reviewed in the earlier part of the Report, and he urged all members to read those pages, because experience had indicated that some among them only imperfectly comprehended what the Association was prepared to do. The Council believed that the best interests of members were served (and the Association existed for no other purpose than to serve them) when there was a direct contact between the members' foundries and the Association. They wanted not merely the point contact, which was furnished by the nominated representative, but in addition a line contact or even a surface contact with the whole foundry organisation. In other words, they wanted the whole foundry staff to understand the nature of the services offered, and to be in a position to call on them if they so desired and the management approved. The Association should not be looked upon as a body external to the industry but as a co-operative organisation of those within it.

External Business Services.

The average business man was not unaccustomed to receiving services from outsiders in connection with his work and to paying for those services as he required them and in accordance with their merit. Since it was claimed that the services of the Association

were, in fact, such as to make membership a business proposition, it might seem curious to some that they should be covered by a single inclusive annual subscription. This was brought about by the fact that H.M. Government would pay grant aid only on regular annual subscriptions, and for very good reasons. When one called on the services of the Association, one called not merely on the services of an individual but on those of an organisation. The members of the Association had temporarily at their disposal a machine which embodied both scientific knowledge and practical experience, and which further devoted a part of its activities to increasing steadily our knowledge of the remarkable range of alloys we called cast iron, as well as of related materials and processes. Scientifically-trained men, such as those on the Association's staff, did not make many demands, but their work was very highly specialised, it was based on a lengthy, arduous and expensive training, and it had to be pursued over considerable periods of time to ensure results. It was fit and proper that they should be able to pursue their work with such a reasonable measure of security as could be offered only by a permanent organisation with a stable income.

Financial Considerations.

This brought him to the most important event of the year. Reference had been made at the last meeting to the fact that H.M. Government, through the Advisory Council to the Department of Scientific and Industrial Research, had agreed on certain conditions to continue grant aid to research associations after the tenth year of their existence—after 1931 in the case of this Association. The Association had to consider, however, the position created by the fall in grant that was due to occur this year—a fall to one-half the original figure. It was felt that the time was not quite ripe for seeking from the industry the difference that would thereby be created, and the Council had placed all the considerations guiding them before the Department. The Association's very warmest thanks were due to the Advisory Council for their sympathy and encouragement, for they had undertaken to continue the grant on the original scale until 1931. This, of course, was subject to certain conditions, and to make the very best use of these the Association required to double its income during the next two or three years. The Council felt this to be well within the range of practical possibilities, because they were aware of the existence of a large and hitherto untilled field. Even now many foundries were largely ignorant of the real purpose and activities of the Association, and the problem resolved itself primarily into the necessity to bring home to all such foundries, including Dominion foundries eligible for membership, exactly what the Association could do for the industry. Such a body as this could not in the ordinary way advertise its activities, and the Association was especially grateful to its good friends the Press for the editorial notice and appreciation they expressed. Therefore, the Association might with advantage during the year invite representatives of the leading technical and trade journals to review its work and to treat it in a way best calculated to appeal to their respective readers. The sum the Association needed was really a trivial one, considered in the light of the possibilities of results from fruitful expenditure—£15,000 a year, of which one-third would be provided by the Department. If the figure suggested in the Report—40 million sterling—as the value of the products of the industry (considered merely as finished castings) were borne in mind, £10,000 per annum was only an *ad valorem* levy of 6d. per £100 of turnover. Surely the industry could afford that in return for the sense of security and the possibilities of progress which the Association offered and which made it a sort of Headquarters Intelligence Staff to the industrial army.

Foundry Exhibitions.

There were two other events to which reference was necessary. The first was the contribution made by the Association to the technical section of the Foundry Exhibition held in London in June last. This was held in conjunction with the Annual Convention of the Institute of British Foundrymen, and the technical exhibit was prepared by a sub-committee of which Dr. Rosenhain was chairman. At the request of Sir Henry Lyons, F.R.S. (who was present at the luncheon), that contribution was subsequently removed intact to the Science Museum at South Kensington, where it had been on view ever since. Sir Henry had stated that the Museum had been visited in that period by some quarter of a million people. Secondly, he referred to the outstanding success of a visit organised by the Association to the German Foundry Exhibition in Düsseldorf and to a number of works in Germany. Evidence was still coming to hand of the educational value of that visit. He did not think there was room for suggesting that the British foundry industry was stagnating when, so soon after the June meeting in London, a party of fifty was prepared to undertake such a visit and to profit by it.

Tributes to Staff.

In thanking all who had assisted the Association in its work, the President first paid tribute to Mr. H. B. Weeks (the Chairman of the Council), who, he believed, had not missed a single Council meeting. All busy men knew how great a call was made upon their time by such work as this, and the Association was to be congratulated upon, and Mr. Weeks to be thanked for, the great services he rendered. (Hear, hear.) Next, the President paid tribute to Mr. J. G. Pearce (the Director and Secretary) and his staff. (Applause.) Knowledge of Mr. Pearce, he said, led one to realise that the Association had in him an exceptionally well-qualified director, and one who would achieve great eminence in his profession in due course. Again, he expressed thanks to the various committees and the managements of the works which had rendered assistance gratuitously during the year. As one who presided over a large industrial corporation he had always in his mind the necessity which lay before British manufacturers of adopting every possible means to effect economy and so reduce the prices of their products. One could not go through workshops of the kind that he had to go through without noting the improvements that had been effected in cast steel, and, above all, the way in which fabricated material was taking the place of cast iron. On the other hand, he was one of those who believed that it was possible, by prosecuting research with a view to improving the quality of cast iron and widening the functions it could perform, to extend its use, and that step would react in cheapening the cost of it—which manufacturers were daily striving to do. He urged the members of the Association to make full use of Mr. Pearce and his organisation, bearing in mind that this country needed the cheapening of its products, and that every step taken in that direction would help us to regain markets which perhaps we had lost temporarily.

Finally, the President urged the importance of recruiting young men into the industry. It was important, of course, to carry out research into materials, processes and methods, but it was just as important to research into the brains which were coming into the industry, and his experience had proved that there were plenty of young men with ample qualifications available.

Dr. F. E. Smith, C.B., C.B.E., D.Sc., F.R.S., who delivered what he referred to as his maiden speech as Secretary of the Department of Scientific and Industrial Research, said he supposed he could not claim the privileges of a maiden and expect his hearers to agree with everything he might say and not throw bricks at him afterwards. He understood that on occasions such as this it was normally the function of the head of the Department to speak at considerable length on the relation of science to industry, but he felt sure that on this particular occasion his hearers would not expect him to say anything about the relation of science to the cast-iron industry—not because he did not know anything about cast iron, because as a fact he was born near Birmingham and had been taught metallurgy by a good teacher, namely, the late Dr. Andrew McWilliam, of Sheffield, though he had not had much experience of cast iron in later years. Feeling, therefore, somewhat like a woman who wanted to pick out a Derby winner, he had read the Report of the Council, expecting that, by studying the work of the Council during the past year, he would find something which he might discuss. Somewhat to his amazement, however, he had read in the Report that "The main work of the Council during the year had been in connection with the conditions under which the Association receives support from H.M. Government." (Laughter.) Then he had felt that he had better try another page, and there he had derived some inspiration. He had read that "The Council is aware that the application of scientific results to practice involves much more than the consideration of individual difficulties or desires. The need for building up a section of the organisation able to deal with industrial applications on a more extensive scale, particularly those arising from research work in progress, has resulted in the formation of a Development Department." That had given him one or two ideas. Naturally, the manufacturers and producers who supported this Association must at times ask themselves certain very simple questions, which it was sometimes rather difficult to answer. They would ask themselves what the organisation was doing, what was its real object, was it going to pay, and so on. At the outset he wished to emphasise that the one fundamental thing which industrial research organisations particularly should be sure about was their real objective. They should be sure that the aims of the manufacturers and producers concerned with those organisations were made clear and tabulated. A very grave defect of many organisations was that they were not particular enough in framing their aims in order to guide research work. For instance, it might be stated that research was to be carried out on short waves; no particular object was stated, and all that was stated was the mere title of something a man was going to handle. Again, one might say that research was to be carried out on cast iron, and leave a man to do what he liked with cast iron. It was important that the researchers and the producers should get together and make it quite clear to each other what their difficulties were, and what were their particular aims, their objective requirements, and tabulate them as clearly as possible in non-technical language. In this connection he paid tribute to the Association because it had so clearly stated the aims of its researches. As illustrating his remarks as to the clearness with which the Association's aims were stated, he referred to a statement to the effect that the aim was "to determine the most satisfactory compositions of iron for light castings, with special reference to resistance to shock." That gave the research worker something definite to attain. Perhaps he would not have stated the aim as being "to determine the most satisfactory compositions," but rather "to produce a more satisfactory iron for light castings," because that was really what the Association was after. Many manufacturers who were contributing to the funds of research associations felt that there was always a tendency for the research worker to work "in the blue." They said that the research worker obtained a certain amount of information, but that they could not use it when they got it. That emphasised the necessity

for them to be specific in framing their programme, so that the research worker was made fully aware of their requirements, and so that his results would be utilised fully.

Applying Research Results to Industry.

Having obtained results from research, the application of them was frequently difficult. There was a tendency for an industry to lag, because, though it knew it could produce better goods, it felt that there was too great an element of speculation in taking the necessary steps to apply the results of research. Then the foreigner got ahead. It was really essential that the results of research were properly followed up and developed, and for that reason he viewed with great satisfaction the statement that the Association was forming a Development Department; it might find it necessary at times to shut down a good deal of its research work and concentrate upon the developments, so that the results of its research would be applied in industry in the minimum of time.

Success of Non-Growth Iron.

One could not complain, however, of the results that had so far been applied to industry. He had noted with satisfaction that there were 300 cupolas in the country converted to the soft type of blast and that they were all giving satisfactory results. Also, very satisfactory results had been obtained with the heat-resisting cast iron which was used for low-temperature carbonisation retorts. In this connection, he said that this year's report of the Advisory Council to the Department of Scientific and Industrial Research contained the statement:—"It is interesting to note that the experimental retorts, which were constructed to the design of the Cast Iron Research Association and made of special material recommended by them, have shown no sign of distortion after fourteen months' continuous operation. This is a most satisfactory result, since the commercial success of this plant will probably rest very largely on the life of the retorts. No other retort yet tested at the Fuel Research Station has had so long a life without measurable and even serious distortion."

Those who knew anything of low-temperature carbonisation, he added, knew very well that small things such as that could turn the scale and make a process a real economic success, whereas otherwise it might be a dismal failure. The statement in the Association's Annual Report with regard to the production of heat-resisting cast irons was gratifying, especially the statement that these irons had been tried sufficiently on an industrial scale to confirm laboratory results, and that Prof. Sir Harold Carpenter, F.R.S., had described the results as revolutionary. Dr. Smith expressed the hope that these results would be fully applied industrially in the very near future.

His advice to the members of research associations was that, having stated explicitly what they wanted, and having enabled the research worker to get on with the work, they should exercise as much patience as they possibly could. It was often a very expensive procedure to cross the bridge of application—the bridge from the laboratory scale to the industrial scale. Both the research worker and the producer had their own particular spheres, but the two must work together.

In order to obtain the best results, the research workers, manufacturers and producers must work in intimate contact, one with the other and express themselves perfectly freely. He was gratified that this Association was as near that goal as were any of the Associations working under the ægis of the department.

Mr. H. B. Weeks, F.I.C. (Chairman of Council) expressed the Council's gratification that the gathering was so large and so representative. He also expressed the Association's indebtedness to the President and Dr. Smith for their inspiring addresses and their advice, and its appreciation of the arduous work of the Director and his staff, who had not merely contributed to, but were absolutely responsible for, any success that had been achieved. The Association was very greatly indebted also to the large band of voluntary workers who had sacrificed their time on its behalf, and had on many occasions placed their plants at its disposal, at considerable cost to themselves, so enabling it to carry out work for which it had not its own facilities, i.e., to demonstrate the possibilities of the application of the results of its scientific researches to the industry itself. Finally, he emphasised the Council's anxiety to do all that was possible to meet the requirements of the members, and he emphasised the great importance of maintaining constant contact with the members in order that the Council should know what they required.

Vote of Thanks to the President.

Sir Arthur Duckham, K.B.E., rising to propose a vote of thanks to the President for his work on behalf of the Association, first took the opportunity, as a user of considerable quantities of cast iron, and particularly at high temperatures, to pay his own tribute to the Association for its wonderful work in the development of cast iron. Undoubtedly, he said, the work of the Association was of the greatest value to those concerned with the use of cast iron at high temperatures.

In expressing thanks to the President, and in paying a tribute to him, Sir Arthur said he had known Sir Philip Nash during the war at the Ministry of Munitions—he was not sure that Sir Philip had not shovelled a job on to him—when he was busy making the name of Geddes famous. He had done great work there; following that he had gone to France with Sir Eric Geddes, and later had carried out magnificently the important duties of Director-General of Transport in France. After that he had tackled industry in this country, and Britishers were conscious of a deep sense of gratitude to him for his work in industry. Industry required to-day men who would tackle all interests therein and bind them together, for we were suffering from a division of industry into two camps—the camp of the administrative capitalists and that of the employees—each of them crying for Government assistance, and there was a hedge between the two which made the proper conduct of industry almost impossible. Sir Philip was a man who was as much at home with the employees as with the employers, and was better able than almost anyone to effect co-operative working, which was so important a factor in achieving success in industry. The members would like to thank him for his work in industry, and particularly for his splendid work on behalf of the Association.

Mr. E. J. Fox (President, National Federation of Iron and Steel Manufacturers), who seconded the vote of thanks, said it must be a matter of considerable gratification to the members of the Association to have Sir Philip Nash as its respected head. Sir Philip was the head of the great electrical industry in this country very much to the credit of that industry and to the benefit of the industries associated with it.

The vote of thanks was carried with acclamation, and Sir Arthur Duckham's call for three cheers for the President was responded to enthusiastically.

The President, in his response, said it was a tremendous pleasure to him to be President of this Association, because he knew it to be a live concern, which was doing constructive work, and was going to do great things in the future. The speeches which had been delivered that day, particularly by Dr. Smith, had filled him, as he knew they had filled Mr. Weeks, Mr. Pearce and all those working for the Association, with great encouragement and hope, and had inspired them to do even more in the future than they had done in the past.

Random Shots.

The Annual Meeting and Luncheon of the Cast Iron Research Association was duly held on November 6, and everyone seems to be agreed that it was most successful. The attendance both at the luncheon and at the formal meeting that preceded it was larger than on any previous occasion, and there were a number of interesting and distinguished guests. I expect you will have an opportunity of reading the speeches in full elsewhere, but in case it is considered too flippant for inclusion in a serious-minded report I must repeat a distinctly apt story told by the President, Sir Philip Nash. It was, as a matter of fact, one of the only two stories told. There was once an old negro driver who claimed that he could flick with his whip any object, however small. He successively demonstrated his powers on a number of objects and was then invited to repeat the performance on a hornet emerging from its nest. He shook his head. "A leaf is a leaf," he said, "an' a fly is a fly, but a hornet's nest is an organisation!"

* * *

The other principal speaker was Dr. F. E. Smith, the recently-appointed secretary of the Department of Scientific and Industrial Research. He confessed that he was making his maiden speech in that capacity, but his remarks were nevertheless extremely interesting. A good deal of attention has already been paid by the Press to his official quotation on the subject of heat-resisting cast irons for the retorts used in low-temperature carbonisation.

* * *

Before I leave this subject, I must do two things. The first is to express a pious hope that future occasions of this kind may be provided with a somewhat different background. I don't mean to imply the slightest criticism of the general arrangements, which were excellent, nor yet of the selected milieu, which was equally excellent, but I did not like the scheme of decoration of that particular suite. Had it been inconspicuous, in the red-brocade-and-old-gilt style that is so usual, it would have mattered no more than the said red-brocade-and-old-gilt does in fact matter on a large number of occasions. But inconspicuous was the last thing it could be called. . . . The other comment I want to make relates not to the meeting but to the recent German trip that was arranged by the same body. At the time I feared that in my enthusiasm I might belong to an inconsiderable minority, but I seem to have proved a true prophet. Direct and indirect evidence of the value of that trip is still coming to hand. In particular a number of Branch-Presidents of the I.B.F. have prefaced their opening addresses by a reference to it, and have then proceeded to talk along lines more or less clearly influenced by what they saw on it!

* * *

I don't as a rule allow any one organisation or event to monopolise my space, but there is no doubt that the C.I.R.A. does count for something in the foundry trade to-day. So that on the occasion of a successful annual meeting a certain measure of preoccupation may well be expected by its supporters and excused by the rest—if there is a rest!

* * *

There are two kinds of men in the world—our friends, and those who don't do business with us.

Marksman.

The Condition and Effects of Graphite in Cast Iron.*

By H. R. Pitt, F.C.S.

The affinity of metallic iron for carbon is a factor which has always to be seriously reckoned with in any endeavour to study the properties and nature of ferrous alloys. In regard to cast iron it may be said that it forms the outstanding and vital constituent, determining its applications and also prescribing its limitations.

Graphite results from the deposition of absorbed and combined carbon which iron has acquired from contact with fuel at high temperatures, and while carbon may be regarded as an invisible ingredient of all forms of iron and steel it is naturally present in relatively high proportion in the blast-furnace product after the prolonged and intense heating and contact with incandescent coke- and carbon-bearing gases.

In all grades of pig-iron the processes through which they pass before becoming actual iron castings are those which have as their object the modifying and, as far as may be possible, controlling of the balance between combined carbon and graphite. Successful methods for the reduction in quantity of total carbon have important effects upon the condition of the remaining graphite, the other elements associated with the iron. Thus in smelting and reduction processes the reduced iron inevitably takes up carbon to an extent dependent upon temperature, time and surface exposed.

Other factors influence the behaviour of iron towards carbon, notably the amount of silicon present derived in the first place from the gangue of the ore. Sulphur, manganese and phosphorus all have separate and marked functions in regard to the relations of carbon to iron which, however, are not within the scope of this Paper, and each element mentioned merits and has received much special attention in this connection.

All the carbon in whatever form it may ultimately be found, has originally been in solution or combination with the metal. Its deposition as graphite may take place in a single stage, when it is called primary graphite, or it may pass through intermediate forms and combinations, which are ultimately decomposed into iron and graphite.

It was at one time almost universally accepted that graphite was of necessity indirectly produced through the carbide system, but in 1906 Benedicks advanced the view that the direct segregation of graphite from the liquid mass probably occurred. He was supported in this view by other eminent investigators, and in 1917 Ruer and Goerens, in further researches, proved that graphitic carbon is capable of deposition, or does segregate directly from the melt or liquidus, or alternatively that the intermediate carbide stage is not necessary to the formation of graphite.

The Physical Properties and Aspects of Graphite.

The allotropic form of carbon known as graphite is an amorphous lustrous black solid; it is highly refractory or heat resistant, absolutely non-volatile, insoluble, capable of oxidation at high temperatures only. Its specific gravity is 2.1, and a point which is not generally noted in this connection is that the specific gravity of cast iron is 7.3, from which it follows that its volume in relation to that of cast iron is as 3.5:1 or that 1 per cent. by weight of graphite in cast iron is equal to 3.5 per cent. by volume. Bardenheuer, in a valuable contribution to this subject in "Stahl und Eisen," May, 1927, has vividly illustrated this, by showing that the relative volumes in the cubic form of cast iron and 2.5 per cent. graphite—8.7 per cent. by volume—is a quite usual proportion even in good castings.

The best known and recognised forms of graphite in cast iron are many; those most familiar to the metallographist are well described by Bolton, the well-known American metallurgist, as: (1) Broad straight flake with background of very fine flakes; (2) rosette or whorl formation; (3) grouped formation, comprising clear definite dendritic lakes, the peninsulars being filled with fine graphite flakes; (4) dendritic striation; and (5) temper carbon.

The large flake formation is found in all irons which have a carbon content over the eutectic composition, *i.e.*, 4.3 per cent. C. The term graphite eutectic is applied to the product of the first decomposition of the cementite eutectic which is shown to exist at and above 1,150 deg. C. Temper carbon is the fine and usually uniformly distributed form of carbon as found in annealed and heat-treated white irons, as a product of the decomposition of cementite, Fe_3C. The ferrite or pure iron surrounding it is the other constituent of this carbide. Temper carbon is chemically identical with graphite. It is also well known as annealing carbon. Hatfield concludes that this form of carbon is the product of the decomposition of cementite, Fe_3C, and it seems to be practically established by the work of Goerens, Wüst and others that graphite is the product of the earliest dissociation of carbide at the highest temperatures as previously referred to.

The form and condition of graphite in iron is influenced by the temperature to which the iron has been raised either in its reduction and in remelting, and it is well recognised that highly graphitic pig produces in castings a very open grain and in this way the physical characteristics of the original iron persist in the final product. The heredity of cast iron is regarded as an important factor in the selection of irons for certain types of castings. Heredity, however, is a rather involved study; in the main it depends upon or is influenced by three factors: (1) The original physical condition of the pig-iron; (2) temperature, and (3) chemical composition.

In the first case, the grain of the pig (mainly a function of the graphite) is a governing factor; the temperature in the blast furnace, together with the speed of melting, the absorption of silicon and sulphur by the metal, and the nature of the burden, all affect the grain by various indirect but important influences.

The effects of temperature in cupola melting, the pick-up of sulphur from coke, the fluidity of the molten iron, the pressure and volume of the blast, the degree of superheat and other conditions involved in cupola practice, are all contributory to the physical and grain condition in the ultimate casting, and will powerfully influence the amount and condition of the graphite present.

Finally, the chemical composition of the pig-iron, especially in respect of the silicon and sulphur content of the iron, forms perhaps the most potent factor in determining graphite condition and grain size or crystalline development in the casting.

The Mechanism of Graphite Formation.

Segregation of graphite in molten cast iron is in every way a process analogous to crystallisation of salt from a solution. At the point where graphite deposition starts, nuclei of graphite first separate, and these nuclei increase by the aggregation of further deposited particles in precisely the same manner as crystal growth proceeds in solutions, the rate of deposition increasing as the temperature falls; crystallisation thus proceeds from individual and isolated nuclei at a regular rate of volume per unit of temperature fall. Curves have been drawn of this nuclear growth, and the effects of the supercooling and under-cooling have been studied.

Under-cooling or super-cooling is the effect produced by the lowering of the freezing-point or point of deposition of a constituent from a eutectic, and may be compared to the feature noted in solutions which below the temperature of saturation fail to deposit any crystals of the dissolved substance until some slight internal disturbance occurs such as the introduction of one small crystal, when the delayed deposition takes place in considerable bulk.

The process of super-cooling in iron can readily be thus understood to bring about deposition of graphite in an abnormal manner, and the number of graphite nuclei rapidly increase as such under-cooling proceeds and an almost simultaneous crystallisation or separation of the graphite occurs, throughout the eutectic, such graphite is consequently in a finely-divided form.

The formation of temper carbon is thus involved at or below the solidification point of the alloy and its collection or aggregation into masses is thus inhibited; while graphite segregating from the liquidus can and does grow by the addition of further flakes as they are thrown out of solution, just in the manner of crystal growth.

A high-total carbon iron will segregate graphite more quickly and in larger quantities as primary graphite, leaving a smaller proportion to be passed through the carbide stage and deposit as temper carbon or to be retained in solid solution as pearlite carbide.

The effects of larger-grained graphitic irons in cupola melting are thus to a great extent explained. The larger the proportion and the greater the dimension of the contained graphite flakes the greater the difficulty of arriving at complete and total solution. Any remaining graphite floating or suspended in the molten metal forms nuclei around which the least fall in temperature brings about further aggregation of graphite, and the condition of the ultimate casting is found to have some of the original high-graphitic character of the component iron.

Here, again, comes the bearing of superheat on the resulting cast to promote solution, but superheat does not of necessity reduce the quantity of carbon present. It may tend to increase it under favourable conditions so that if undissolved carbon persists in a highly-saturated liquidus, cooling will rapidly produce graphite flakes upon and around such particles which remain, as they form nuclei for segregation.

Graphitisation of Non-Carbon Alloys.

The iron-carbon diagram does not account for all the observed facts noted in examining cooled iron-carbon alloys, that graphite makes its appearance throughout the whole process of cooling down to temperatures well below the solidas curve, and here it cannot be doubted the other elements present play prominent parts and in applying the evidence of the diagram to the cooling of a casting in the mould we are at once confronted with complications due to the presence of silicon, sulphur, etc.

Excess graphite in hyper-eutectic irons separates out at high temperatures while the metal is still fluid, and by virtue of its gravity rises to the surface and the primary form of graphite known as "Kish." When such irons are subjected to the extremest methods of quenching, free graphite is found present. Hyper-eutectic irons do not produce the primary Kish form.

The condition of the graphite in an iron is the greatest factor influencing its strength and

* A Paper read before the West Riding of Yorkshire Branch of the Institute of British Foundrymen, Mr. W. G. Thornton presiding. The Author is Chief Metallurgist to Messrs. E. Green & Sons, Limited, of Wakefield.

physical qualities, for Bardenheuer and Zeyen proved by experiment that a chilled cast iron subjected to annealing had a better mechanical strength, though it consisted of a ferritic matrix than a sand-cast sample with a pearlitic matrix, the reason obviously being that in the ferrite mass the graphite was very finely divided, while in the pearlitic graphite was in larger flake form.

DISCUSSION.

The President (Mr. W. G. Thornton) asked Mr. Pitt what effect graphitic carbon had on the growth of cast iron. He had noticed, during the works visit, some castings of stoker links and was rather surprised to find they were cast of white iron. He thought perhaps that was done to overcome the question of growth. Growth on a stoker grate had been a difficulty for some time. Mr. Thornton said he had been very interested to see on the screen, during the address, the three diagrams of Emmel iron. He believed it was generally understood that Emmel iron, along with Perlit, etc., was known for its uniform qualities in regard to section. He meant, it did not vary in its composition due to the thickness of section. Some time ago he (Mr. Thornton) had experimented a little with Lanz iron. He cast a piece in wedge form, 6 in. thick, 8 in. long down to nothing, and 12 in. broad the other way. This was drilled down the centre and then split, and he was amazed at the fracture it exhibited. With the naked eye one could hardly see any difference. That iron on test stood 26.83 tons tensile. Mr. Thornton said if Mr. Pitt could give any information as to how to control carbon content of metal in the cupola it would be very helpful. Mr. Thornton said he would also like to ask Mr. Pitt if he found in his blows any difference in the constitution of the iron in the first and second tap to the last blow?

Mr. Pitt said it was very important, in any iron that was to be affected by heat-treatment, that the carbon should be in at least a fine-grained condition. They must have a condition in which the balance between combined carbon and graphite was in favour of the combined carbon. There had been fairly good results with iron containing up to about 3.5 per cent. of total carbon, but that carbon had been in a very fine condition and the sections had been usually fairly thin. In regard to the question of the stoker links, these were a small casting. No definite final conclusion had been come to in regard to them. The particular links seen that afternoon were being made to specification, and he was not sure they could be regarded as in anything but the experimental stage. If he was making stoker links to the specification he deemed desirable, he would probably make them of a heat-resisting iron of very fine close structure—not necessarily white. Emmel iron was based upon a very short freezing range. One had a highly-developed pearlitic matrix and the iron was very thoroughly homogeneous. In regard to the wedge-shaped sample of which Mr. Thornton had spoken, Mr. Pitt thought the cooling had probably taken place at pretty much the same rate from its edge to the thick part. In regard to the question as to graphite control in the cupola, one could control to some extent, and it was very largely by careful controlling of the component irons. If one had large graphite to start with, one could rely upon the graphite persisting. By superheating, giving the iron a quick drop through melting range and keeping it hot in the well, it could be controlled to some extent. The first taps of a cupola were almost invariably higher in combined carbon, and consequently relatively lower in graphite, than the last; but the chief reason, he thought, was due to the sulphur pick-up from the bed coke and the longer time the charge was in contact with that bed coke when it came down. It disturbed the relationship between the combined and graphitic carbon.

Mr. H. Forrest (Bradford) said he had been struck by the reference to agitation of molten iron and that the graphite would separate more readily when the molten iron was separated. He (Mr. Forrest) had noticed that very often there was a segregated area. He did not know whether it was entirely due to the condition of the graphite or to other causes.

Mr. Pitt said the question of agitated cast iron was one which had several different aspects. He appreciated Mr. Forrest's point. He had said a disturbance of graphite when it was in a high state of fusion would need to be in a rather coarse form. A meeting of two streams in a mould would have rather a different effect. One had two streams of metal, almost certainly at different temperatures, and there would be a different degree of concentration of impurity, and the impact of the two metals mixing would lower the temperature of the higher one and tend to raise the temperature of the lower, and one might produce an area where larger graphite formation was in evidence. It was a matter that would depend largely on the distance that one or both of the streams had flown and the readiness with which they would cool down, and one might get a range of almost any conditions over a spot where the two metals met in a mould.

Mr. Thornton said he had had an experience in which agitation had refined the iron by blowing the carbon from it.

Mr. Pitt said that in that case one Bessemerised that iron. Bessemer set out to make wrought iron, but he overdid it for time and his iron was oxidised. Mr. Thornton (suggested the speaker) was lucky in his treatment that he did not oxidise any of it except the carbon. Even that was remarkable, because it was not until the silicon practically disappeared that the carbon became oxidised at all. All attempts that he had known to produce a refined iron by blowing had failed to get a good balance, and the result was a very heterogeneous and, possibly, partly-burnt iron.

Mr. Hammond (Bradford) asked did Mr. Pitt consider the pressure of the metal in individual moulds had any effect on the iron?

Mr. Pitt said the effect of pressure would usually be to hold the graphite in solution a little longer, and the graphite would come sooner to the freezing range, but one really got a smaller graphite, failing other conditions which might produce quite the reverse effect. He would not care to make a definite statement on the effect of casting under pressure in various sized sections.

Mr. Holdsworth, referring to the agitation of cast iron, said one might be liable to get into serious trouble sometimes in agitating it in the shank before it was poured into the mould.

Mr. R. D. Welford (Bradford) remarked that a semi-steel mixed iron depended for its quality on the reduction of carbon in the iron. Had Mr. Pitt any idea of the percentage effect of, say, 20 per cent. steel in reduction of graphitic carbon and total carbon?

Mr. Pitt said the effect of any percentage of steel to a charge depended on more than one factor. It depended on the kind of iron in the mixture. It depended on the temperature and generally upon the oxidation or relation of the blast to the temperature in the cupola. Adding a 20 per cent. charge in a normal way, assuming a normal charge giving about 2 per cent. of silicon and 3.5 per cent of total carbon, an iron of medium strength and fairly open grain, the addition of 20 per cent. steel would probably reduce down the carbon to, say, 3.2 to 3.25 per cent. under normal conditions. It would close the grain of the iron to an appreciable extent and give probably 1½ to 2 tons extra tensile. There were, of course, many other conditions to be taken into account in a matter of that kind.

Mr. S. W. Wise (Hon. Secretary), proposing a vote of thanks to Messrs. Green and to Mr. Pitt, congratulated Mr. Pitt on his intensive research into the various conditions of graphite. Mr. Pitt would no doubt agree that much that had been written about graphite had to be re-written in the light of further knowledge and looked upon from a very different standpoint. Some of the most fruitful discussions of that branch of the I.B.F. had been held in Messrs. Green's canteen hall, and Mr. Pitt had helped the members on several previous occasions, especially on this particular subject. Mr. Pitt was very much at home on this subject and perhaps he was a bit beyond some of them in that regard, but they were glad to hear his views on this matter, and as they jogged along, season after season, perhaps some of them would eventually attain to something like the high-technical standard which the lecturer had attained.

Mr. R. D. Welford, seconding, said Mr. Pitt had managed to put a very scientific subject into as simple and understandable a form as was possible. The slides thrown on the screen had helped to illustrate the differences in various forms of graphite. Everybody, of course, knew they had graphite in iron, but there were many who did not sufficiently appreciate the different forms of it and the varying effects they had on the test, especially on the water test, of the finished product.

Mr. Pitt briefly responded.

Welsh Foundries Inspected.

Members of the Wales and Monmouth Branch of the Institute of British Foundrymen spent a most interesting afternoon on November 9 inspecting the blast-furnace plant of Messrs. Guest, Keen & Nettlefolds, at their Dowlais Works, Cardiff. The works contain an up-to-date plant for the manufacture of pig-iron, especially high quality hematite pig-iron, and the party were fortunate in arriving just in time to see the tapping of the latest type of furnace, which has an output capacity of over 3,500 tons per week. The steel melting and rolling mills were also visited, but were not in operation.

Following this, a visit was paid to the works of Messrs. John Williams & Sons, Limited, immediately adjoining. Here the different departments were found interesting. The renowned steel window-frame department received interested attention, as also did the machinery for cutting steel bars and sheets. From there the visitors went on to the foundry, where sand slinger, jolting machines, sand thrower, pneumatic riddles, etc., were all put in operation for the benefit of the visitors.

At the conclusion of the inspection the party partook of tea provided by the firm in its canteen, after which the President, Mr. W. S. Kinsman, called upon Mr. R. G. Williams to propose a vote of thanks, which was seconded by Mr. Ben Hird and supported by the Hon. Secretary, Mr. J. J. McClelland.

Members and visitors then journeyed to the University College, Cardiff, where Professor Read, D.Met., delivered a lecture on "Making Iron from Primitive Times."

Presentation at Denny Iron Works.

The staff and employees to the number of about 200, of Messrs. Cruikshanks & Company, Limited, Denny Iron Works, assembled recently to mark in tangible form the marriage of Mr. James Mercer, superintendent of the cast-iron department. Mr. John M'Laren, director and secretary, presided, and referred to the high esteem in which Mr. Mercer was held. Mr. Tom Shanks, works manager, then presented Mr. Mercer with a handsome oak escritoire and bookcase, and said that he expressed the wish of all present that Mr. Mercer's future would be filled with happiness. Mr. Mercer, who has a reputation as an entertainer, replied in characteristic manner, and indicated how highly he appreciated their kindness.

Some Notes on Cupola Receivers.

By M. G. Woods.

From time to time various mechanical handling and distribution systems have been devised and introduced into the foundry to effect economy and speed up the rate of working. With this end in view, methods have been tried for producing a higher efficiency in the manipulation of the metal at the cupola. In this direction apparatus known as receivers have, and are being used to help to produce a higher efficiency in the metal manipulation. Most foundrymen have very vague ideas as to the function and use of receivers, and refer to them in a very casual manner, not realising it is an important adjunct to the cupola, and very few could tell whether any advantages would accrue from the installation of a receiver in their melting plant. Thus, to meet this general need of clear, concise information on the subject, the following notes have been collated, and they deal with the various types of receivers and their individual features.

Principle of All Receivers.

The principle of all receivers is that they should be receptacles primarily for the storage of molten metal. The metal, as it issues from the cupola, is allowed to collect in the receiver until the required quantity is ready. Thus the use of a receiver sets the furnace free as a melting unit only, the cupola not being required to store any metal in the well. This results in economies, which will be considered later.

Varieties of Cupola Receivers.

There have been several types of receivers introduced, all of which have some commendable feature, such as an iron- and slag-separating device, jolting receiver, receivers heated by external means to impart super-heat to the metal, and also for desulphurising by the Rein

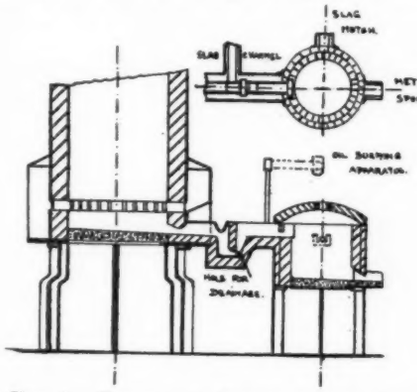

FIG. 1.—CUPOLA AND RECEIVER WITH SLAG-REMOVING DEVICE BY THE WHITING CORPORATION.

(German) process. The most elementary form of a receiver is a ladle, it being mounted on trunnions in a suitable position just in front of the tap hole on the cupola, and is provided with suitable tilting gear, either hand or power operated, their capacity being regulated by the melting speed of the furnace. They can, generally speaking, hold the products of one hour's melting.

The Whiting cupola and receiver may be regarded as an example of melting plant employing a method of separating slag from iron. The cupola is of the drop-bottom type, and an outside receiver is employed, also fitted with a drop bottom, and provision is made, if required, for oil-heating the receiver. The slag-removing device is situated in the channel by which the metal flows from the cupola into the receiver. It consists of a step of the underside of the channel, and a lug of firebrick projects vertically into this step. A smaller shute leads out at right-angles to the main channel at the top of the lug. An examination of the plan and elevation, as shown in Fig. 1, will show the arrangement of details. The principle underlying this method of separation is quite simple; the iron and slag issue in a stream from the cupola as melted, the iron beneath the slag, owing to its greater specific gravity. The liquid flows in and fills up the step, and the iron flows into the receiver. The slag, being lightest, floats on the top, and thus is trapped. As the volume of slag increases with the flow of the metal, it is raised up to the level of the smaller channel, into which it flows. This device allows very little slag to pass into the receiver, and what little does can soon be tapped out by the slag notch on the receiver.

Jolting Receivers.

Dr. Dechesne has evolved a theory of desulphurising cast iron in a receiver by the mechanical action of jolting. Previously, methods for desulphurising were by the use of thermal or

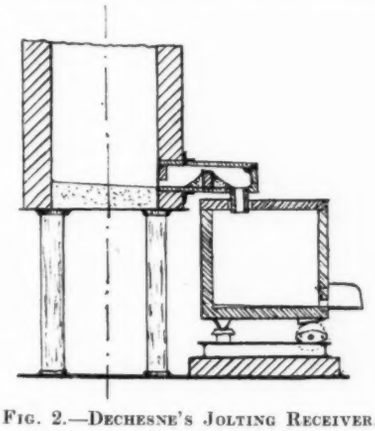

FIG. 2.—DECHESNE'S JOLTING RECEIVER.

chemical means. This theory depended on the fact of the different relative densities of the impurities, they being lighter than iron. For example, manganese sulphide has a relative density of 4.00, whereas that of iron fluctuates around 7.50. Thus, these impurities, after having risen to the metal surface, can be drawn off as slag. This theory was drafted into practice, and some surprising and gratifying results were obtained. It was found that the physical properties of the iron, after agitation, were materially improved, insomuch as to cause the primary idea of desulphurisation to become of secondary importance. Dechesne's receiver in which his experiments took place was of rectangular box shape, lined in the usual manner, the connecting channel being hinged at the cupola junction. In this channel a slag-separation device is fixed. The receiver is fitted with a slag notch and metal-tapping spout. It is jolted by a cam fixed on a shaft, which is operated through worm gearing by an electric motor, and is fixed under the front end of the receiver. The cam gives a lift of about 1½ inches at a speed of about 100 jolts per min. Reference to Fig. 2 will render the arrangement clear. From this process a high-class iron has been produced. A reduction of 55 per cent. of the original sulphur present has been experienced. By this receiver complete mixing of the metal constituents is obtained, affording a homogeneous product. As a result of the agitation the occluded gas is expelled, any oxides present are reduced, and a regular distribution of the graphite flakes occurs. It is claimed that a close-grained reliable iron, with tensile strengths varying from 13 to 21 tons per sq. in. (the average of a series of tests being 18.8 tons per sq. in.), and the Brinell hardness figures varying from 189 to 240, the average being 218, can be procured.

The object of oil-fired receivers is, in most cases, to provide fluid metal with a high degree of super-heat. This super-heat is appreciated by those who manufacture malleable castings, or anyone who is using low-silicon and phosphorus irons. Super-heat is also being recognised as a cure for castings containing blow-holes, resulting from oxide reduction.

Hurst's Receiver.

Hurst's oil-fired receiver may be taken as an example (Fig. 3). The receiver contains a refractory brick-lined bath and roof, capable of holding 2-3 tons of liquid metal. The oil burners project the flames of combustion on to the surface of the metal, and on to the stream of molten iron as it is melted, and flows into the receiver, thus keeping the metal at a high temperature and imparting super-heat. The products of combustion are carried off by passages over the metal channel into the cupola. The fuel consumption of this process varies from 5 to 8 galls. per hr., including oil for heating up receivers at the commencement of a melt. Naturally, the fuel consumption per ton of iron will vary according to the tonnage of metal passing through the receiver.

Various methods have been introduced for desulphurising molten iron. In principle the process consists of treating slag-free iron with suitable alkaline re-agents. The cupola and receiver as used in the Rein desulphurising process may be taken as an example. The details of this process, which have a connection with receivers, are the lining and arrangement of the plant. Both the cupola and receiver are of standard design. The wall of the former is built so that

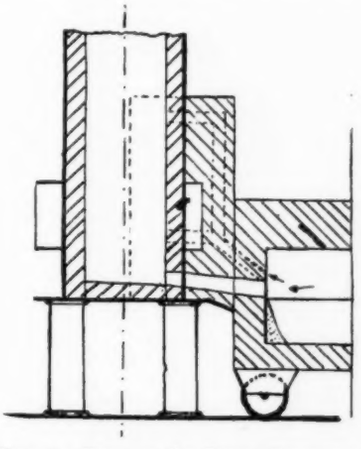

FIG. 3.—TYPE OF OIL-FIRED RECEIVER.

it overhangs that of the latter. A slag-separating device is built into this juncture, the slag leaving the cupola by a channel into a totally-enclosed slag receiver. Thus only slag-free iron issues into the metal receiver, The receiver lining in this case must receive attention owing to the reaction which takes place. It consists of ordinary hard burnt fire-bricks, with an alumina content of 40 per cent. They are built as closely together as possible, and the joints made sound by a material of the same composition as the bricks. Some receivers for this process have their lower section well covered with loam mortar after every run, and any cracks which develop during heating or use must be repaired. The receiver in this process is heated before each melt. Fig. 4 shows the plant and slag-removal arrangements.

E

Outside Receivers.

At present, in general foundry practice, two types of receivers are in use, these being the "outside" and "inside" type. The Thwaites melting plant, embodying the "outside" receiver, may be taken as an example of the former type. This plant consists of a cupola of standard design directly connected with the receiver. This receiver is a circular chamber, varying in size according to the melting rate of the cupola, and built on a solid foundation. It is lined with ordinary fire-bricks as used for a cupola lining, and covered with two semi-circular sections of fire-clay. A slag notch and ordinary tapping hole are provided. A tuyere is fixed over the tapping hole directly opposite the closed

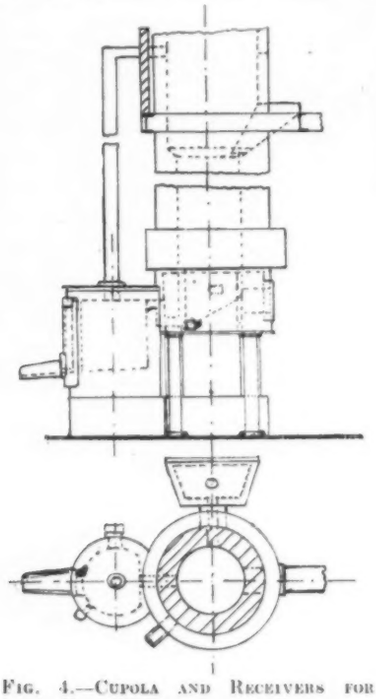

Fig. 4.—Cupola and Receivers for the Rein Desulphurising Process.

channel by which the metal enters the receiver, so, in case of obstruction in the closed channel preventing the metal flowing into the receiver, a rod may be inserted through the tuyere into the metal channel, and the offending material removed. A vent pipe, ganister lined, is fixed in the centre of the receiver roof, which carries away the gases from the receiver interior and reintroduces them into the cupola at a point above the air belt. The receiver hearth is lined with the same material, and in the same manner, as that of the cupola. This type of receiver is in use at several foundries at the present time. This plant is illustrated in Fig. 5. In this sketch the receiver roof lining is of fire-brick, and not as stated above.

"Inside" Receivers.

The Matchell receiver is of the "Inside" type (see Fig. 6). The only practical difference of this type from the Thwaites is that the former is fixed directly under the cupola, a hole in the cupola hearth allowing the fluid metal to drop into the receiver as melted, whereas the Thwaites receiver is placed just in front of the furnace, as shown in Fig. 5, the advantage of the latter being that a drop-bottom cupola may be installed, which considerably lessens the difficulty of cleaning and repairing than by using the breast hole. In some melting equipment where an "inside" receiver is used, it is mounted on a bogey or truck, and can be withdrawn from under the furnace, thus allowing the use of a drop-bottom cupola. The Roper cupola and receiver is on this principle. This plant, it is claimed, eliminates the necessity of a breast hole and cupola sand hearth, for the hearth is constructed of fire brick set in a hinged steel framework, which gives all the advantages of a drop-bottom cupola. This plant is useful when the floor space is limited.

Most of the types of receivers mentioned are either still in the experimental stage, or they have not yet been widely applied, although the Matchell and Thwaites receivers are in use in a fair number of foundries. To the writer's mind the oil-fired types have a future, for foundrymen are appreciating more and more the value of hot metal for the production of clean, sound castings. The Thwaites receiver, which seems to be in more general use, and, as it happens to be the one with which the writer has had practical experience, the following comments will chiefly be concerned with this type.

Advantages of Receivers.

With a cupola alone the risk is always present, that of the slag rising up and flowing into the tuyeres and air belt, thus causing trouble, expense and delay. With a receiver this danger is eliminated, for all slag removing operations are outside the cupola, either by a slag-removing device, as in the Whiting receiver, or by means of a slag notch, as in the Thwaites type. By this the cupola is kept free from the scouring action of the slag, thus prolonging the life of the lining and keeping it cleaner. With an oil-fired receiver, such as Hurst's, the metal can be kept hot for casting practically indefinitely, even after the cupola has been dropped, thus saving time and expense, for, ordinarily, the cupola must be kept running until all the metal has been tapped out. With a Thwaites receiver the hot gases from the furnace play upon the metal surface, thus keeping the metal hot. In the Matchell

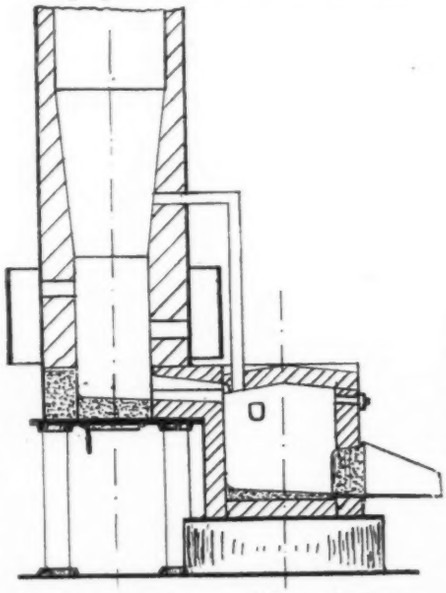

Fig. 5.—The Thwaite "Rapid" Cupola and Receiver.

type the hot gases play vertically on to the metal surface, which has more effect than that of the flames playing parallel to the metal surface as in the Thwaites type. Ordinarily the fluid metal lies in the well of the cupola in close proximity to burning coke. This metal will tend to combine in chemical union with the sulphur and carbon in the coke. Generally speaking, high sulphur content in cast iron is objectionable, owing to its effects on the physical properties of the iron. By using a receiver an iron can be produced with low total carbon and sulphur contents. An economical advantage obtained by the use of a receiver is the reduction in the amount of bed coke required. With an ordinary cupola the fluid metal is stored in the well or hearth, thus allowance must be made when designing such cupolas to fix the air belt in such a position as to allow sufficient volume of metal to accumulate in the well for casting. This allowance for the metal increases the amount of bed coke necessary.

A study of the diagrams reveals the fact that on all cupolas with receiver the air belt is placed very low. With a receiver the height of the tuyeres from the hearth may be reduced to a minimum, as no metal is required to be stored in the hearth. Intimate mixing of the charge is obtained by the use of a receiver, an important factor when one is including anything up to 25 per cent. steel in the charge. It will also be noticed that the Dechesne type of receiver does this by the jolting action.

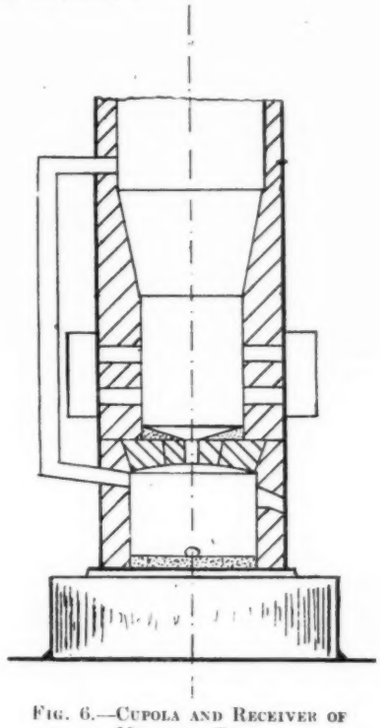

Fig. 6.—Cupola and Receiver of Matchell Type.

Disadvantages of Receivers.

The use of a receiver introduces a difficulty with regard to the separation of the charges. This difficulty becomes a problem when one desires to produce two irons of different composition from the same heat. It is more difficult to produce irons of different composition from a melting plant including a receiver than with a cupola alone. Separation of the charges can only be remedied by judicious charging, utilising an extra coke charge before and after charging the second iron. This extra coke will shield the second iron and hold up the melting whilst it is being burnt. Receivers other than oil-fired have the disadvantage of chilling the first metal melted. With an oil-fired receiver this chilling is removed, as it can be pre-heated to the metal temperature. With the Thwaites type it is customary to light a wood fire inside the receiver at the same time as the cupola is lit. Also two hearths have to be made up, for the cupola and receiver. Both the preceding facts involve time and expense, which introduce high maintenance costs. With the Matchell type, only the receiver hearth is made up, because the cupola hearth is constructed of fire brick.

Conclusions.

After reviewing the preceding remarks one can see that there is much to be considered before installing a receiver in order to increase (or otherwise) the melting efficiency. In the light of practical experience, the value of a receiver, to the writer's mind, depends solely on the class of castings being manufactured. Where light, small, and intricately-cored castings are being

(*Continued on page* 356.)

Electric Hoists in Foundries.*

Transportation is a matter closely connected with foundry operations, and their influence on each other is very great. Bringing raw and other materials to the foundry from the store-rooms and stockyards, charging the cupolas, assisting in transport during the preparation of the moulds, carrying the patterns and ladles to the casting place, transporting the finished castings to the cleaning shop, the stock rooms, or the loading station for despatch, and, finally, returning the patterns to the patterns store are amongst the many purposes for which transporting appliances chiefly enter into consideration in foundries.

In view of the great diversity of operations thus involved in foundry handling, and the substantial weights to be manipulated, which may be 15 to 200 times the weight of the castings produced, according to the method employed and the equipment of the shops, it is obvious that the economic operation of the plant will be dependent, in a large measure, upon the way in which conveying is organised. Inadequate plant and non-observance of the fundamental rule, that transportation should take place by the shortest possible route and by the cheapest method available in practice, may be responsible for exorbitant costs of conveying, sometimes rising to 75 per cent. of the wages bill, or $\frac{1}{3}$ of the manufacturing price. In modern foundries with restricted programmes, working on lines of wholesale production, the costs of conveying may, on the other hand, drop to $\frac{1}{5}$ or $\frac{1}{8}$ of the wages bill and $\frac{1}{10}$ or even $\frac{1}{20}$ of the cost price.

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Fig. 1.—Mono-Rail Crab with Driver's Seat and Two Electric Hoists for Twin-Rope Grabs.

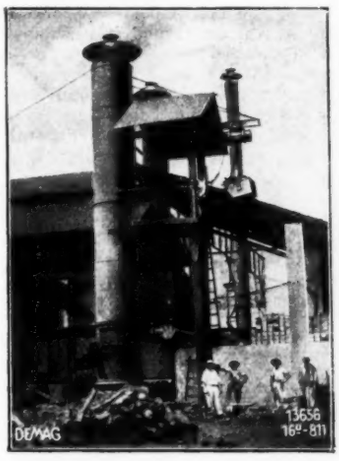

Fig. 2.—1-ton Electric Jib Hoist charging a Cupola Furnace.

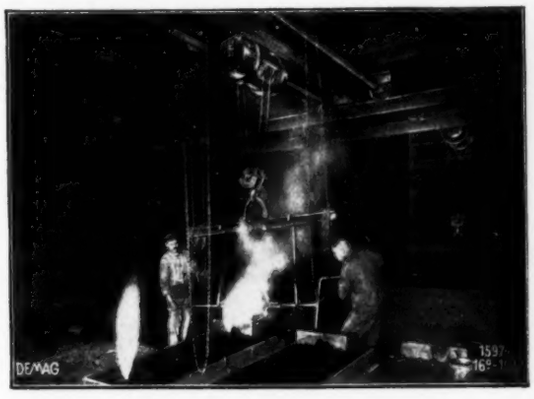

Fig. 4.—Hand-Operated Traveller with 2-ton Electric Hoist for Ring-Carrier Ladle.

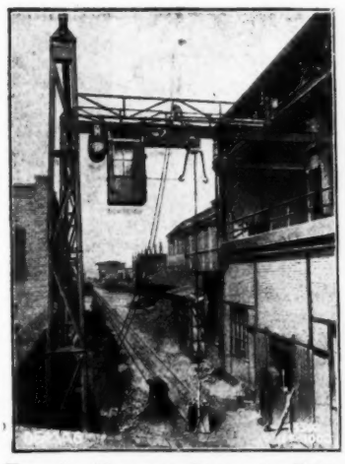

Fig. 3.—Electric Hoist in Crab with Driver's Seat, used to charge a Cupola Furnace.

The load capacity of every hoisting appliance should be adapted both to the weight and the size as well as the nature and specific properties of the raw and other materials and castings dealt with. Where parts of fairly small individual weight occur regularly, it is usually better to transport them, either separately or together, in small quantities by means of fast lifting tackles with low-load capacities, instead of letting a large number accumulate and then transporting them by means of more powerful appliances. Smaller plants are cheaper to buy and, for such purposes, mostly give better rates of utilisation and consequently result in lower costs of conveying.

Moulding heavy castings also involves lighter kinds of transport, which would be performed far too expensively with the crane handling the finished product. Such incidental hoisting work should be carried out with small auxiliary tackles of suitable size. Provided, at every working place, they not only relieve the workman but materially increase output as well.

Small hoisting appliances for foundries must satisfy very exacting requirements. They must be insensitive to the effects of dust so copiously encountered in foundries; neither should they be affected by the fumes of the casting process, or the heat radiating from the molten metal. Practical experience in foundries shows that Demag electric hoists are dependable in this respect, being wholly insensitive to all such influences. The Demag hoists work with the utmost reliability and precision, even with the very smallest lifts and traversing distances. Owing to these properties, they have proved eminently satisfactory for more delicate work in the moulding department, such as withdraw-

Fig. 5.—Ladle Repair Shop. Gantry Crane with 5-ton Hoist in Twin-Rail Crab. Remote Control.

Fig. 6.—36 Hand-Traversed Electric Hoists in Hand-Operated Travellers. Load Capacity p. Hoist: 2 Tons.

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ing patterns, inserting cores, placing boxes on one another, removing copes, etc. Generous dimensions, together with precautions completely preventing their being overloaded, are essential for the hoists in view of the long working periods frequently demanded. For stationary work, in which the hoist is only required to raise and lower the loads, it is made in two modifications, viz., either with an eye for fastening it above, or as a floor hoist to be set up in different positions, with the rope leaving it at any desired angle. If it is necessary to move the load sideways, or some distance, the hoist can be installed rigidly in slewing or portable crane frames, or in traversing crabs driven by hand or electricity. The crabs travel on girders or overhead tracks with switches, turntables and travelling platforms, or on stationary, slewing and traversing crane frames, etc. Where the distances to be covered are rather long, and high rates of utilisation are wanted, high-travelling speeds and, consequently, high-conveying outputs are obtained by dispensing with operations from the floor level and changing over, instead, to a separate operator for whom a seat is provided on the hoist itself or in the shape of a trailer coupled with it. The hoists with crowned or spherically-turned central poles, they can also be used in breaker plants to do away with the well-known disadvantages of the tup, the risk of damaged eyes and the difficulties of recovering the tup when buried amidst the scrap. Rectangular-loading magnets, with rigid or movable poles, find application predominantly for lifting and stacking pig, old bar iron and rails, etc. Movable poles are an advantage in that they neutralise slight differences of level of materials handled, the active pole area and lifting power of the magnet, hence increasing considerably. The starting controllers or switches for scraps, hoists should be installed a good distance away from the hoists themselves in order to prevent the operator being hurt by pieces not held securely and consequently dropping down. Alternatives likewise satisfying this requirement consist of employing remote control or control from an operator's seat combined with the hoist.

Charging elevators or hoists serve to carry the raw materials from the storage places to the cupolas and to deposit them in the shafts of the latter. Electric hoists have been adopted here in many instances to improve the efficiency of obsolete plants with hand-operated winches, cranes, and such like, are among the many appliances successfully modernised by resorting to electric hoists. Fig. 4 shows a shank being emptied; it is attached to the hook of a 2-ton hoist by an intermediate carrier with iron suspension links. This hoist was put in the crab of an existing crane that was previously worked by hand. Fig. 5 is a view of a subsidiary department in a big foundry, namely, the shop where the ladles are repaired. The ladles arrive here on lorries and a 5-ton hoist in a twin-rail crab takes them off and puts them aside. After being repaired and relined with refractory bricks, the hoist puts them on a lorry again which carries them back to the foundry. The twin-rail crab has remote control and works on a frame or gantry crane with hand-traversing gear.

In the moulding shop electric hoists are used for transporting boxes, withdrawing patterns, inserting cores, lifting copes, or setting them down on the drags and similar purposes, examples of which will be found in Figs. 6 to 8. As in all other departments of foundries, it was likewise found that in the moulding shop, manufacturing expenses could be curtailed very considerably by cutting out manual work wher-

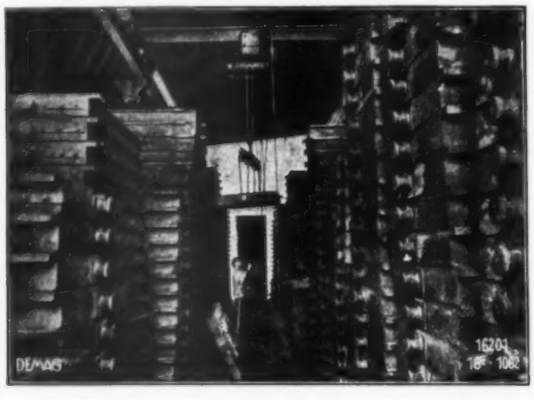

Fig. 7.—1-ton Hoist with Hand-Traversing Gear in the Flask Store.

Fig. 8.—5-ton Hoist with Electric Traversing Gear, coupled with Driver's Seat. Hoist placing Cope on Drag with Bath Mould.

may be equipped with buckets, grabs and loading magnets for handling raw and accessory foundry materials, or fitted with tups to serve as scrap breakers. Special tackles on the lower blocks adapt them for dealing with flasks, patterns ladles and similar objects.

The illustrations give a brief review of the countless potential uses to which Demag hoists may be put in foundries. Hoists with grabs unload the raw and accessory materials from the trucks in which they arrive, carrying them to the store depôts and yards, whilst magnetic materials, such as pig-iron and scrap, are dealt with by hoists equipped with loading magnets. The single-rope grab can be worked with one hoist only, whereas two are needed for twin-rope grabs, a pair of hoists being combined in a crab with driver's cage, or in a twin-rail crab with remote control (Fig. 1).

Scrap iron-castings arriving in pieces not suitable for the cupola furnace, i.e., pieces over 66 lbs. each and measuring more than 1.64 ft., must be broken up further on the way from unloading to the store. Impossible to break by hand, such pieces must go to a breaker plant, the tup of which is usually in the shape of a pear, with ring or eye for fastening. Mostly, the tup weighs something like 2 to 4 tons. It is gripped with a tong-shaped hook on the lower block of the hoist and raised about 10 to 25 ft. At the top, a rope pull opens the hook and releases the tup which crashes down on the cast-iron pieces beneath, smashing them to pieces.

Round-loading magnets are usually employed for conveying scrap of every description. Fitted and they have always been found to reduce the working expenses materially by completely abolishing all manual work. Fig. 2 shows a 1-ton hoist with hand-traversing gear running on a jib above the charging platform in a small foundry in the tropics. The full tipping buckets with slanting discharges are hoisted to a level above the platform and then drawn in by a coolie, who tips the contents into the furnace shaft. The design in Fig. 3 is a great improvement on this rather crude plant. Here the 3-ton hoist is attached to the rear end of a jib crab, with operator's self-contained seat in much the same as with a long-type crab. The bucket with bottom discharge can therefore be run right into the interior of the furnace shaft, dumping its contents inside. For emptying, lateral suspension rods are fastened to the bucket with the aid of a hand lever so as to detain it, and the hinged traps at the bottom consequently begin to open as the hoisting ropes are further lowered. When empty, raising the hoisting ropes closes the trap again. Having detached the suspension rods, the bucket may be run back from the shaft and can then be lowered to fetch a new charge. Highly economic and efficient charging plants reaching every part of the foundry yard, and yet needing very little initial outlay, can thus be obtained by simply extending the mono-rail track system for the travelling hoists.

Many existing plants are improved and rendered more efficient by installing electric hoists for carrying the ladles of molten iron from the furnace to the mould. Hand-operated foundry cranes, antiquated types of electric travelling ever it is possible to do so at all, increased performance by the moulders have, indeed, inevitably followed the introduction of Demag electric hoists in all foundries adopting them.

Some Notes on Cupola Receivers.

(*Continued from page* 354.)

produced, the metal is required in small quantities and with a high degree of super-heat. With this class of work a receiver produces no advantages, and it is best to take the metal straight from the cupola with no intermediate handling. On the other hand, if the metal is required in large quantities for heavy work, a receiver is useful for keeping the metal at the desired casting temperature whilst waiting for the specified quantity. With a receiver as already mentioned, there is trouble experienced by mixing when two or more qualities of iron are being produced. This disadvantage can only be kept to a minimum by carefully timing the charges, and rapid despatch of the special mixtures as melted. With these precautions, irons of different composition may be produced fairly independently of one another as regards chemical analysis. Intimate mixing of the charge becomes a necessity in order to produce iron consistent and reliable in quality.

With this in view, a receiver is of great advantage when the charge consists of a mixture of pig-iron, cast iron, shops returns (such as risers, runners, etc.), and steel scrap, and is required in large quantities at a time, as the metal is well mixed, and the temperature is kept within the casting range.

Notes on the Routine Analysis of Cast Irons and Iron Foundry Raw Materials.

By Arthur Smith, M.A.

Carbon in Cast Iron.

Cast irons are essentially complex iron-carbon alloys containing greater or less quantities of other elements according to their purity. Carbon may exist in cast iron in several forms, the most notable being the elemental form commonly known as graphitic or free-carbon or simply as graphite. However, the strength and general physical properties of any sample of cast iron depends not only on the amount, size and distribution of the free or graphitic-carbon, but also, perhaps to a greater extent, on the percentage of carbon chemically combined with the iron as iron-carbide as well as the physical structure and arrangement of this same carbide.

In molten cast iron, the whole of the carbon exists in solution as carbides of iron and other metallic elements, and the phenomena associated with the cooling of such a solution closely follows phase-rule principles, the influence of elements other than carbon varying with the amount and nature of the elements present. In the case of pig-irons, the metal which collects in the well of the blast furnace is essentially a solution of carbon in iron, the amount of carbon required to bring about saturation at any given temperature above the melting-point depending largely on the amount of other elements being present, other things being equal. When this mass of molten metal, in cooling down, approaches the freezing-point, some carbide of iron is thrown out of solution, usually accompanied by dissociation into its elements. After solidification various changes occur, the final proportions of the total-carbon existing as carbide and graphite respectively, depending on the rate of cooling through the range of temperature down to approximately 700 deg. C. If the rate of cooling from the freezing-point to this temperature is sufficiently slow then no carbide will remain and the whole of the carbon will be in the form of graphite. A perfectly-annealed sample of ordinary cast iron will show this.

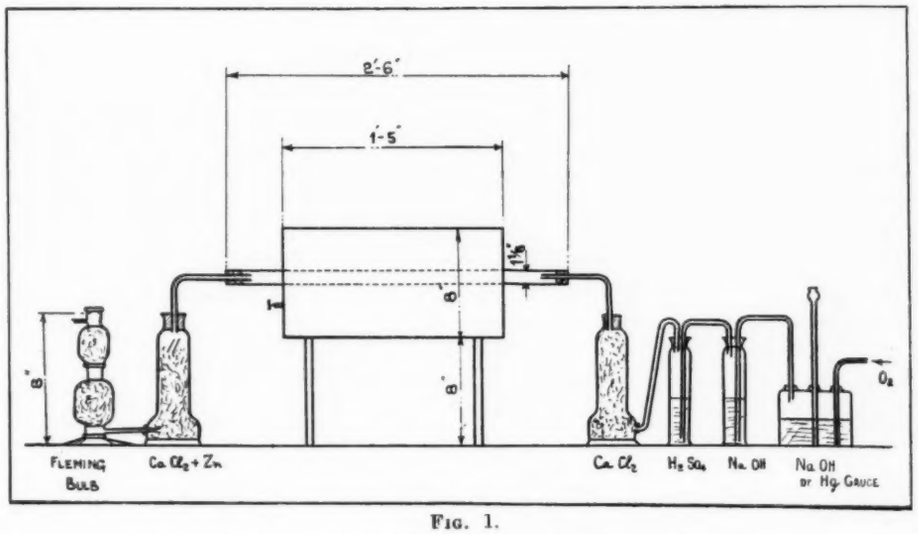

Fig. 1.

In the soft grey irons, an all-pearlitic matrix is usually associated with a combined carbon figure of 0.85 to 0.89 per cent., but in some cases an all-pearlitic structure may contain as little as 0.65 per cent. combined-carbon. In the lower total-carbon cast irons of the high-tensile type small differences in the total-carbon content may make quite appreciable differences in the casting properties of the metal. Again, in the lower-silicon cast irons the ratio of total-carbon to silicon is extremely important, as, under exactly identical cooling conditions, cast irons of equal silicon content, all other things being equal, will show a tendency to hardness and chill in inverse ratio to the total-carbon content, very small reductions in total-carbon having a marked effect, especially in the region below 3.0 per cent. total-carbon.

Difficulties in Sampling.

Hence, it will be seen how highly important it is that the estimation of total and graphitic-carbon in pig-irons, and cast irons intended for high-duty castings, should be carried out with the greatest skill and that accuracy should be certain in every sample. In these estimations, speed, of course, is also desirable, but great accuracy is the first essential. The initial difficulty which presents itself is the obtaining of a representative sample. It must be remembered that the graphite present is often reduced to a fine powder under the drill, and the precautions of sieving and taking proportional masses from each grade of the sample is essential to accuracy. Recently the author read of someone advising magneting treatment to eliminate non-metallic impurities in samples of cast iron. This is quite all right for steels and completely cementitic irons, but since graphite is a non-metallic constituent (*not impurity*) of grey cast irons, such a procedure would give very inaccurate results. Provided the drillings have been carefully taken from a clean-fractured face of the sample of pig-iron or cast iron which has been previously sandblasted or scratch-brushed all over, there will be no fear of contamination.

Although the carbon in grey cast iron exists as graphite and combined-carbon, it is usual to estimate the total-carbon and the graphite in the sample and to obtain the percentage of combined-carbon by difference.

Estimation of Total-Carbon.

Always provided a correct sample has been obtained, the methods for estimating carbon in steels are applicable to samples of cast iron, the amount of sample being altered to suit the particular case. The chief methods depend on the conversion of the whole of the carbon in the sample, to carbon-dioxide by combustion in oxygen either with or without the separation of the carbon from the iron. In the case of samples of grey cast iron, it is usual to adopt the direct-combustion method, and the author can confidently recommend this method as being the best in the hands of junior assistants, provided the required apparatus is selected with care.

Outline of the Method.

The sample (2 grms. for grey cast iron) is placed in a suitable tube-furnace heated to 1,000 deg. C. A stream of purified oxygen is passed through the apparatus, and the carbon is thus converted to carbon-dioxide, precautions being taken to ensure that the oxidation will be complete. The escaping gases are freed from sulphur-dioxide and water-vapour and passed through a vessel containing soda-lime, solid caustic-potash, a solution of caustic-potash, or any other suitable absorption agent, and the increase in the weight of the vessel and the absorbent gives the amount of carbon-dioxide obtained.

The apparatus which the author uses exclusively for cast iron, and finds that it gives excellent results in the hands of a conscientious operator, consists of the following parts (Fig. I):

Furnace Proper.—The essential part is the *combustion tube-furnace*. Where possible this should be electrically heated, preferably of the resistance type, where the heating elements consist of compressed crystalline carborundum. However, when carefully handled, excellent results can be obtained from furnaces wound with nickel-chromium alloy wire, the winding being protected by suitable heat-resisting plaster. In both cases the furnace should be properly lagged with magnesite or similar material and arranged to take one, two or four tubes as required. If the working temperature is sufficiently high, then the estimation can be carried out so rapidly that one operator can only do justice to a two-tube furnace. In the case of the carborundum heating elements the required temperature can be not only attained more quickly, but, where 1,000 to 1,050 deg. C. is desired, it is always available without fear of shortening the life of the heating element. With the nickel-chromium alloy windings, failures often occur due to oxidation and electrolysis of the wire, and no matter how good the lagging and protection of this type of winding, continuous use at 950 to 1,000 deg. C. renders the life of such heating elements disappointingly short and renewals frequent.

The length of the tube-furnace should be such that a 24-in. combustion-tube will give at least 8 in. projecting on the absorption side of the train.

Where electric current is not available, a gas-fired combustion furnace must be used, but only in very exceptional cases is this necessary.

Combustion-tubes.—These are usually made of such refractory materials as fused opaque silica, alundum, porcelain, or fine fireclay. The internal diameter should not be too small, $\frac{3}{4}$ in. or 1 in. being the normal size, so as to allow of the use of reasonably-sized boats. The author is very much in favour of the fine-clay tubes such as are made by the Morgan Crucible Company. The author has found, after prolonged trials, that this type of tube gives the best results. A refinement which cuts out the use of a rubber plug at the absorption end, is to have the tubes made with a reduced-diameter "prolong" at one end.

Combustion Boats.—Fused silica, alundum, porcelain or fine fireclay are again the materials most used for the vessel to contain the sample of drillings. Platinum, of course, is perhaps best, but the author prefers to use cheap boats made of fireclay. With a bottom layer of pure, carbon-free silica or alundum, such boats will last for several estimations, and the author prefers the type manufactured by Messrs. Beecroft & Partners, which is cheap yet serviceable. In some laboratories it is the custom for the staff to make their own boats, but this is not an economical practice.

Absorption Apparatus and Absorption Agents.

These have been designed in almost innumerable forms. Of necessity, the general type of design varies according as to whether the absorbent is a liquid or a solid.

The essential features are:—(*a*) Lightness combined with reasonable robustness. In this respect some types of CO_2 absorption-apparatus are ridiculously fragile for routine laboratory work. At the same time the weight of the apparatus when filled with absorbent should be low, so that accuracy may be maintained in the differential weighings; (*b*) the apparatus should take a charge sufficient to last through a reasonable number of estimations, consistent with total weight; (*c*) the apparatus should be so designed as to be easily cleaned, dried, filled and handled; (*d*) means should be provided for readily and easily closing the inlet and outlet tubes in the apparatus, and (*e*) the design should be such as to give efficient absorption without risk of any CO_2 passing through and should be provided with a drying-trap for moist atmospheric air.

The author is very much in favour of the use of a solid absorbent such as soda-lime. This material can now be readily purchased with an indicator which shows by change of colour when the material has become converted into carbonate. "Ascarite" and "Carbest" are other types of trade mixtures specially prepared for absorbing CO_2, but the author finds it most convenient and economical either to add an indicator to medium-grade soda-lime or to buy the ready-made material cheaply under the name of "Sofnolite" (Sofnol, Limited), in which the indicator change is from green to red. The advantage of such an indicator is twofold. Not only does it show when the absorbent is becoming exhausted, but it also shows up any irregularity of absorption due to uneven packing or uneven quality and grain-size of the absorbent.

The ideal absorption vessel for such a solid absorbent as that described is that known as Fleming's Absorption Bulb. The vessel is very readily cleaned, dried and filled. The moisture guard is integral with the absorption bulb; the apparatus is very stable and robust; the inlet and outlet tubes can be instantly opened and closed by the simple operation of turning the ground stoppers. Provided one sees that the manufacturer keeps the weight down by having the vessel blown in very light glass, then it is the ideal form of absorption vessel, and its adoption leads to a speeding-up of this class of work when carried out by junior assistants. The remainder of the apparatus consists of suitable drying and wash bottles for purifying not only the issuing gases, but also the oxygen used for combustion. The author uses the following train, as detailed below, but there are many variations which will probably give equally good results. The main object sought is simplicity combined with efficiency, and the design should be such as to minimise, if not entirely prevent, troubles due to leakage.

Details of Combustion Train.—(1) Oxygen supply, consisting of a cylinder of oxygen fitted with pressure-regulating valve and pressure gauge; (2) mercury monometer-type pressure gauge to detect leaks and stoppages; (3) large wash bottle containing concentrated caustic-potash solution; (4) large wash bottle containing concentrated sulphuric acid; (5) double drying tower containing calcium chloride and soda lime; (6) combustion tube containing sample in clay boat, followed by large boat or similar vessel containing copper oxide (granular) or platinised asbestos, with loose plugs of asbestos before and after this second boat; (7) drying tower containing granular zinc to absorb sulphur, chlorine, or other acid fumes. Where litharge is used for aiding the combustion of such alloys as ferro-chrome, etc., fumes arising therefrom are absorbed; (8) drying tower containing phosphoric anhydride to remove water; and (9) Fleming type absorbent and weighing apparatus.

An actual estimation is carried out as follows: The furnace is heated to, and maintained at, a temperature of 960 to 1,000 deg. C. Each furnace is supplied with a suitable variable rheostat to control the temperature. The temperature should be checked, by means of a suitable pyrometer, at least twice a week and the ampereage taken as an indication of the temperature. In the newer furnaces, of the carborundum type, a thermo-electric pyrometer is an integral part of the outfit.

When the necessary temperature has been reached, a slow stream of oxygen is passed through the apparatus and the absorption bulb is weighed until constant in weight. Meanwhile a 2-grm. sample of the cast iron has been weighed off into a clay boat, in the bottom of which a thin layer of pure, ignited, acid-washed, silica sand has previously been spread. The absorption vessel is placed in position with both inlet and outlet taps open; the boat with the sample is placed in the mouth of the combustion tube and pushed into position by means of a carbon-free metal rod; the connection between the oxygen drying tower and the combustion tube is made good and a moderately slow stream of oxygen is passed through the train. Combustion will usually be complete in three to five minutes, always provided the furnace temperature is high enough, but the burning should be continued for 12 or 15 mins. The drillings should be completely oxidised or burnt, but should not be fused. The oxygen must flow sufficiently rapidly to provide a large excess round the sample, but not so rapid that the sample is in danger of being too violently heated with resultant formation of slag by combination with the sand or boat. When the combustion period is complete, the inlet and outlet stoppers of the Fleming bulbs should be closed, and this part of the apparatus disconnected and weighed. When filling or refilling the absorption apparatus, it is essential that it should be weighed full of oxygen plus absorbent. The increase of weight gives the amount of carbon dioxide absorbed, and this figure multiplied by 0.2727 gives the weight of carbon present in the sample, which when multiplied by 50, gives the percentage.

With this simple type of train, provided always an accurate sample has been obtained, no difficulty should be experienced in getting total carbon estimations in pig-irons to check to within at least plus or minus 0.03 per cent. For routine work, the accuracy of the estimations should be tested by running standard samples (as supplied by Ridsdales, the N.P.L., or Iron and Steel Institute) of cast iron alongside unknown sample, at least once a week.

Some authorities recommend the mixing of oxidising agents such as litharge or bismuth oxide with samples of pig-iron or cast iron, but, provided the temperature of the furnace and other details are carefully adhered to, the use of oxidising agents should be unnecessary.

A Novel Apparatus.

Recently, a very convenient form of apparatus for the direct combustion of carbon to carbon-dioxide in iron and steel samples has been designed and put on the market. It is known as the "Ströhlein Apparatus for the Determination of the Carbon-Content in Iron and Steel," and the novel feature is the absorption of the carbon dioxide in caustic-potash solution contained in a special type of gas burette giving direct readings in percentage of carbon.

The sample is burned in a stream of oxygen in the usual type of single tube electric furnace heated by means of carborundum rods to a temperature of 1,000 deg. C. exactly as already described. The stream of purified oxygen passing through the combustion tube carries the carbon dioxide from the combustion of the sample, together with the remaining oxygen, into a burette, in which the gases are collected up to a definite mark shown by the water which serves as sealing liquid. The gases are then led to the absorption tube, which is filled with caustic-potash solution, where the carbon dioxide is absorbed. The residual gases are then returned to the measuring burette, where the amount of carbon present in the sample is shown by the decrease of volume. The range of the burette, which is graduated in percentages (using one gram sample) is 0 to 4.5 per cent. carbon for the cast-iron range. The same apparatus is also supplied for steel samples with a burette range of 0 to 1.5 per cent. carbon.

The results obtained are good, and the apparatus is very suitable for routine work, operation being very simple, and complete estimations can be made very rapidly. It is, of course, necessary to observe the temperature of the sealing solution and the atmospheric pressure, and a correction table is supplied to give the necessary adjustment without the necessity of making the calculation.

Either of the above methods will give much greater all-round reliability when dealing with total-carbon in samples of cast iron than any of the solution and combustion processes often used successfully for steels.

Estimation of Graphitic-Carbon.

The general method usually adopted is to dissolve the sample in acid and thus liberate the free-carbon, which is filtered on carbon-free, purified and ignited asbestos in a suitable container, the graphite carefully washed free from iron-salts and subsequently burned in oxygen in a similar manner to that already described for total-carbon.

A 2-grm. sample is dissolved by gentle heating in 60 c.c. of dilute (1.20 sp. gr.) nitric acid to which has been added three drops of hydrofluoric acid. Heat gently to near the boiling-point for five to ten minutes, but on no account should the sample be vigorously boiled, else the graphite is not so readily filtered. Filter through a small, elongated Buchner funnel, preferably made of transparent quartz, of such dimensions that it can be pushed into the combustion-tube. It is also possible to obtain filtering-tubes made of alundum which will answer the same purpose, and can be used without any asbestos pad. If such equipment is not available, then the asbestos pad with the graphite must be transferred to the usual combustion boat. A very wide range of suitable filtering apparatus can now be obtained in Jena quartz-glass with the filtering discs fused in. The discs may be obtained in three grades of porosity, and from experience the medium grade has been found the most suitable for this work. This type of filtering apparatus is made in various styles, from the crucible variety to the elongated micro-funnel. Foundry chemists engaged on grey cast-iron analysis, who are not already familiar with this type of filtering apparatus, would be well advised to give it a trial. It is comparatively inexpensive, yet it is much more convenient than any type of "Gooch" crucible, asbestos pad or glass wool filtering apparatus, and any slight additional cost is very quickly discounted by the greatly increased speed of working. The same type of filtering apparatus can also be obtained in Jena quality transparent fused quartz, and by the use of micro-funnels of this quality it is possible to push the filter with its graphite residue direct in the combustion tube.

No matter which type of filtering apparatus has been used, the graphite residue must be very carefully washed with caustic potash solution (1.10 sp. gr.) till the washings are quite colourless and the residue is free from combined carbon. It is then washed with distilled water, dilute hydrochloric acid, and finally with distilled water. This washing must be done very thoroughly, because it is often very difficult to free the residual graphite from the last traces of combined carbon. The graphite is now dried and then transferred (preferably without removing it from the filtering apparatus) to the combustion tube, the estimation being completed exactly as already described for total-carbon.

Unless this procedure is adopted and closely followed, widely varying results may be obtained from the same sample of cast iron, even when the method of sampling is known to be above suspicion. In all cases the filtrate from the

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graphite should be passed through a fine-grade filter-paper to see whether all the graphite has been retained on the asbestos pad or other filtering apparatus. Any black stain on the filter-paper will show leakage of graphite, and the estimation must be repeated on a fresh sample.

Combined Carbon in Grey Cast Irons.

In samples of cast irons and pig-irons it is usual to take the combined carbon as the difference between the amounts of total and graphitic carbon found.

Not under any circumstances can the colour method be recommended for cast-iron samples. Where an approximate idea of the combined carbon is required in any sample when it is not intended to determine accurately the total and graphitic carbon, the simplest way is to prepare and examine microscopically one or more sections taken from the casting.

In some cases it may be necessary to attempt to isolate the amount of carbide of iron present in any sample as distinct from carbides of manganese, chromium, etc. Much work has been done in this direction on alloy steels by J. O. Arnold and A. A. Read. The method used by these investigators is briefly as follows. The samples of steel in the form of polished bars are electrolytically decomposed in pure dilute hydrochloric acid (sp. gr. 1.02) in a form of apparatus where the sample is one pole and a platinum plate screened by a porous pot or diaphragm is the other pole of an electric current. Ferrous and other chlorides go into solution and hydrogen is evolved at the platinum plate. The carbides so isolated adhere to the residual steel. The current is switched off after a definite number of hours have elapsed and the carbides are scraped from the underlying steel bar, which is subsequently weighed, the difference between this and the initial weight of the bar giving the amount of sample operated upon. By subsequent estimation of the amount of carbon, iron, manganese and chromium, etc. (if any), present in the carbides we arrive at the distribution of the combined carbon between the iron and other metals present in any sample of steel. In the case of cast irons, free graphite complicates the matter, but it seems feasible that, having already estimated the amount of free carbon present in any sample of cast iron, then some modification of Arnold and Read's method might be useful.

Alloy cast irons containing metallic elements other than iron and manganese, *i.e.*, containing nickel, chromium and other metals in solution and in combination, appear to be likely to occupy a very prominent position in high-duty cast irons of the future, and consequently the estimation of the metallic carbides in such cast irons is worthy of the closest attention by metallurgists engaged in the cast-iron industry.

The Estimation of Carbon in Ferro-Alloys.

Most samples of ferro-alloys contain considerable quantities of carbon usually in the form of carbides. The actual amount of carbon present in such alloys is really of no great consequence when they are applied to the manufacture of grey cast iron, but the additions are usually such a small percentage of the total charge as to be insignificant in their influence on the percentage of total-carbon in the final mixture.

However, where it is necessary to estimate the amount of total-carbon in such alloys as ferro-silicon, ferro-manganese, ferro-nickel, ferro-chromium, ferro-aluminium, ferro-titanium, etc., in almost every case the only method likely to give reliable results is direct combustion in oxygen. With such alloys as ferro-chromium, it will usually be found essential, not only to increase the temperature of combustion to somewhere in the region of 1,100 deg. C., but it will also be found advisable to make use of some oxidising agent, such as pure red lead, pure lead peroxide, bismuth oxide, manganese dioxide, or similar oxidising agent.

Ladle Changes in Composition of Steel and Slag.

At a recent meeting of the American Institute of Mining and Metallurgical Engineers, slag action in a ladle of steel from the open-hearth furnace was discussed by Dr. C. H. Herty, who submitted the two accompanying diagrams.

Fig. 1 shows the changes in the concentration of metalloids in the steel, beginning 3 min. after the start of tapping the heat from the furnace and running up to the twenty-eighth ingot

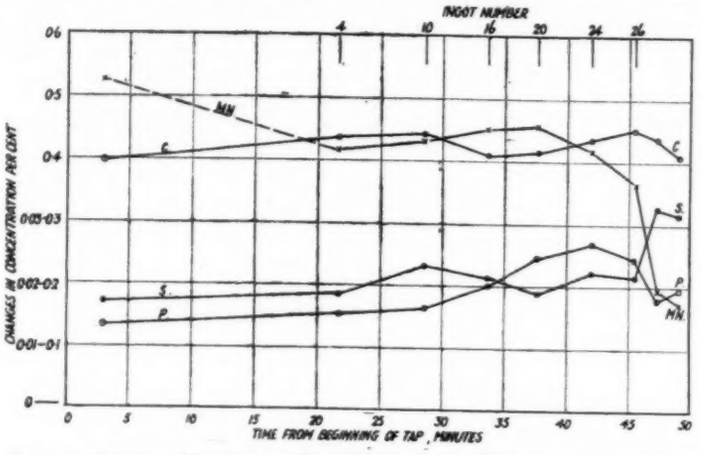

Fig. 1.—Showing Changes in Concentration of Metalloids in Ladle of Open-Hearth Steel before and during Teeming.

teemed from the heat 46 min. later. This shows, among other things, the sharp reduction in the proportion of manganese as the last few ingots were reached. The sulphur took a sharp rise, while phosphorus made a similarly abrupt drop.

In Fig. 2 is shown the concentration of the slag constituents. Most pronounced among the changes here is the rapid increase in silica from

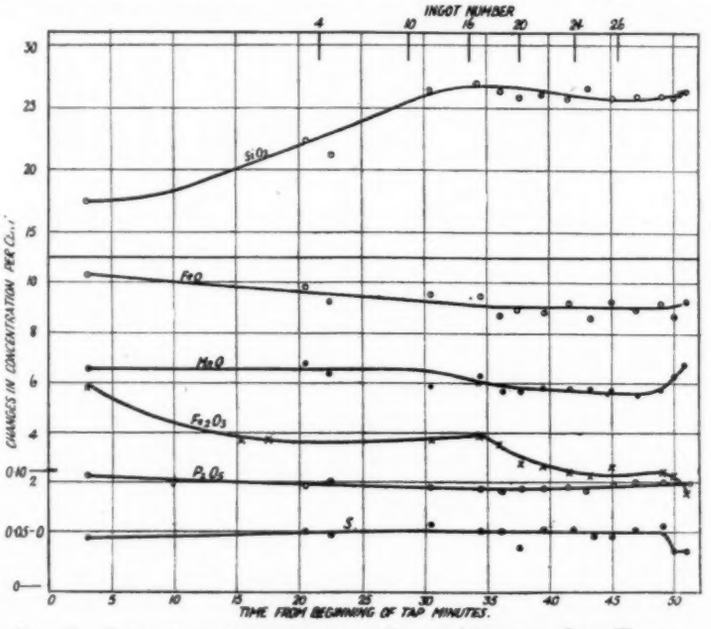

Fig. 2.—Changes in Composition of Slag in Ladle of Open-Hearth Steel before and during Teeming.

the time the heat was tapped until about 15 ingots had been poured. After this the silica content was about stationary. At the same time, there was a considerable drop in ferric oxide during the first portion of the period, and then, after a time of stability, a further drop following the sixteenth ingot. Other elements show less abrupt changes, as will be noted from the curves.—"The Iron Age."

Publication Received.

A.W.P. Electric-Arc Welding Operators' Handbook.—We commend the enterprise of Messrs. Alloy Welding Processes, Limited, of Ferry Lane, Walthamstow, London, E.17, for having had the good sense to provide the men destined to use their material with a set of simple, yet well-chosen, instructions. For this purpose they have prepared a booklet consisting of 38 pages of printed matter supplemented by an inset containing a mass of welding data and a number of well-chosen illustrations of interesting jobs. Where A.W.P. have undoubtedly scored is by the attention which they have paid to the metallurgical side of their job and which the reviewer, as a metallurgist, sincerely appreciates. Whilst the book carries a sales message, we should not grumble if a charge had been made for it, and we hope that though it is placed at the disposal of our readers free of charge, they will accord it a place in their technical library rather than amongst the catalogue section.

Messrs. Bolckow, Vaughan & Company, Limited, Middlesbrough, have decided to blow out one of their blast furnaces producing Cleveland pig-iron.

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Trade Talk.

Fifty-seven furnaces were in blast in Belgium during August. The country's output of steel castings for the month was 10,310 tons.

According to a report from Hamburg, a new brass foundry is to be laid down in Bengal, the construction and equipment for which is to be carried through by Krupp, of Essen.

William Jarvie, a labourer at the Dalzell Steel Works of Messrs. David Colville & Sons, Limited, Motherwell, fell into the casting pit and sustained injuries from which he died almost immediately.

Messrs. George Brown & Company, Limited, Greenock, have obtained an order to build a cargo steamer of 1,600 tons deadweight for Continental owners for service between London and the Continent.

The Great Western Railway Company has placed a contract for the provision of transformers in connection with the electricity supply to the nine new 3-ton cranes at South Dock, Newport, with Messrs. Crompton Parkinson, Limited, Chelmsford.

The Turkish Government are reported to have placed an order with three German firms for the construction and equipment of a steel plant near Angora. The buildings will be constructed by Gutehoffnungshütte, the machinery by Demag and the electrical equipment by the A.E.G. The plant is to cost about £850,000.

The Engineering Employers' Federation has arranged to meet representatives of the Amalgamated Engineering Union and other organisations in the engineering trade on Thursday, November 21, to discuss the claims of the unions for an increase on the present basic wages of time workers of 8s. per week, with corresponding alterations in piece rates.

The National Executive of the Iron and Steel Trades Confederation, in view of the election of Mr. James Walker, Scottish Divisional Organiser, to Parliament, have appointed Councillor Owen Coyle as Scottish Divisional Officer in his place. Mr. Coyle has been for a number of years assistant organiser.

One thousand wooden-framed mineral wagons, each of 12 tons capacity and of the Railway Clearing House standards, have been ordered by the L.N.E. Railway from outside contractors, for delivery by the end of the current year. Messrs. Hurst, Nelson & Company, Limited, Motherwell, have received the order for 150 of these wagons.

Shareholders of Agricultural & General Engineers, Limited, have been informed that the report and accounts for the year ended March 31 last are being prepared in accordance with the requirements of the new Companies Act, 1929, and will be issued shortly. The company's valuers are engaged in valuing the works and plant of the subsidiary companies.

The cargo steamer "Blairsprey," of 4,140 tons gross, built by the Ardrossan Dockyard Company, Limited, and engined by Messrs. John G. Kincaid & Company, Limited, Greenock, for the Northern Navigation Company, Limited (George Nisbet & Company, Limited, managers), Glasgow, has completed very successful trials on the Clyde. The speed attained was 11½ knots.

As a result of the decision of Messrs. Bolckow, Vaughan & Company, Limited, to blow out a blast furnace producing Cleveland iron, 100 miners and datal workers at the company's South Skelton ironstone mine have received a fortnight's notice to cease their employment. Some of them may find work at the Loftus mine of Messrs. Pease & Partners, Limited, where a number of experienced miners are required.

The Canadian Pacific Company's new 25,000-ton liner "Empress of Japan," building at the yard of the Fairfield Shipbuilding & Engineering Company, Limited, Govan, Glasgow, is nearing completion, and will be launched on December 17 by Mrs. E. R. Peacock. The 40,000-ton liner "Empress of Britain," building for the Canadian Pacific Company at Messrs. John Brown & Company's yard at Clydebank, is expected to be launched early in January.

The works of the Hardy Patent Pick Company, Limited, at Heeley, Sheffield, were badly damaged by fire on Tuesday, November 5. The outbreak occurred in the saw mills, and spread to the general offices and other parts of the works. Important departments of the works which escaped the fire include the coal-cutting machine shop, the drawing office, the foundry, and the pattern-shop. It is stated that, of the 800 men employed at the works, from 300 to 400 will be thrown out of work through the effects of the fire.

The directors of the British Dardelet Threadlock (D.D.G.) Corporation, Limited, announce that delivery is now being made of the necessary plant and machinery, and that production on a large scale of the Dardelet thread will begin early in the New Year. The first section of the factory at Acton for the production of bright bolts has been erected. Options on land adjoining the factory for further extensions have been secured. Preparations for marketing the company's products at home and overseas are in progress.

Members from Derby, Nottingham, Leicester and Loughborough attended the second meeting of the session of the East Midlands Branch of the Institute of British Foundrymen, held at Derby. Mr. H. J. Young, of London, who had been announced as lecturer, was unable to attend, and it was agreed to open a general discussion on the cupola, which proved most instructive. Mr. J. Lucas, who presided, expressed regret that Mr. Young was unable to attend, as they had been looking forward to hearing his views on "The Loss of Money and Lack of Progress due to Rule-of-Thumb Methods in Ironfoundry Practice."

Two twin-screw motor-propelled oil tankers, each 13,500 tons deadweight, are to be built by Messrs. Lithgows, Limited, Port Glasgow, for Messrs. Westfal-Larsen & Company, of Bergen, Norway. The vessels will be fitted with Harland "B. & W." internal-combustion engines aggregating 4,000 horse-power, and are due to be delivered in the first half of 1930. They will be named "Langanger" and "Storanger" respectively, and they will be similar in all respects to two vessels built in Holland last year for the same owners. They represent, therefore, the diversion of Norwegian work from Holland to the Clyde.

The directors of Messrs. Williams & Williams, Limited, steel casement manufacturers, etc., Chester, in a progress report, state that the option on 50,000 ordinary shares has been exercised, and the shares have been paid for in cash. Of the 100,000 convertible preference shares, which carry the right of conversion into ordinary shares until 1931, 62,069 have been converted. The issued capital, therefore, now consists of 37,931 8 per cent. convertible preference shares and 246,470 ordinary shares. During the last six months the enlargement of the Chester works has been further advanced and new machinery added. This and the consequent reorganisation of the works are now almost complete.

The annual meeting of the Trent Ironworks Sick Club was held at the Old King's Arms, Kirkgate, on November 7, when the President (Mr. W. Harly) tendered his resignation, as he will not be available for the office at the expiration of the present year. Mr. C. L. Darnell was elected as the new president, and, following the election of officers, the opportunity was taken of presenting Mr. W. Harly with a handsome expanding dining-table. In making the presentation, Mr. Darnell paid tribute to Mr. Harly's ability and sterling qualities, and thanked him especially for all he had done for their club, expressing the members' regret at losing his services as president. Mr. Harly, in reply, thanked the chairman and his fellow-workmen for their kind remarks and thoughtfulness.

Obituary.

We regret to announce the death of Mr. F. A. J. FitzGerald at his home in Niagara Falls, Ontario. By birth an Irishman, Mr. FitzGerald was a founder of the Acheson Graphite Company and a past-president of the American Electro Chemical Society.

Mr. Lewis H. Drew, of Messrs. Rownson, Drew & Clydesdale, Limited, iron and steel merchants, London, died at Clevedon, Somerset, recently, aged 75. Mr. Drew retired from active participation in the business, with which he had been connected for over half a century, a few years ago.

Mr. George W. Peard, whose death occurred on October 31, in his 62nd year, will be chiefly remembered as a joint patentee of the Bates & Peard annealing furnace, a well-known method of annealing non-ferrous metals. Mr. Peard joined British Insulated Cables, Limited, in 1899, to start the new copper mills which this company were then erecting. He was superintendent of this department up to the time of his death, and saw it grow from small beginnings until it now gives possibly the largest copper output in this country.

Personal.

Mr. Andrew Wallace, J.P., director of Messrs. N. Cockburn & Company, Limited, Falkirk, has been elected to the Town Council of Falkirk.

Mr. Archibald Logan, organiser, Central Ironmoulders' Association, has been re-elected a member of the Town Council of Falkirk. He has also been reappointed bailie.

Mr. S. R. Beale, managing director of Messrs. L. Sterne & Company, Limited, Crown Iron Works, Glasgow, and chairman of the Glasgow Chamber of Commerce, has been elected a director of Messrs. Guest, Keen & Nettlefolds, Limited.

Mr. P. J. Hale has arrived in England from Chicago to assume the position as resident engineer for the Foreign Engineering Company in connection with the blast furnace that company are building for the Ford Motor Company at Dagenham.

Mr. W. J. Molyneux, who for many years has been foundry manager to Messrs. Clarke, Chapman & Company, Limited, of Gateshead, has joined the staff of Messrs. Lake & Elliot, Limited, steel, malleable and grey iron founders, of Braintree.

Mr. Norman Cockburn, of British Bath Company, Limited, Greenford, has retired from active participation in the foundry industry. Mr. Cockburn has been a member of the Scottish Section of the Institute of British Foundrymen since 1917.

Mr. J. F. Moss, a director and London manager of Messrs. Edgar Allen & Company, Limited, has decided to retire, and has tendered his resignation. He has been in the service of the company for about 39 years. The firm hope to retain still his services in connection with special work.

Mr. W. B. Lake, senior director of Lake & Elliot, Limited, steel founders and engineers, Braintree, who for the last two years has been President of the London Branch of the Institute of British Foundrymen, has now been elected a member of the Council of the British Cast Iron Research Association.

Mr. G. R. T. Taylor has resigned his appointment as deputy-chairman of Vickers, Limited, but retains his seat on the board. Mr. G. G. Sim, C.S.I., C.I.E., has been appointed deputy-chairman in his place. Mr. J. Reid Young, C.A., has been appointed secretary to the company in place of Mr. Sim.

Mr. Arthur Colegate, who has had wide commercial and financial experience as a director of Messrs. Brunner, Mond & Company, Limited, Synthetic Ammonia & Nitrates, Limited, and other companies, has been appointed a managing director of Messrs. Marshall, Sons & Company, Limited, engineers, Gainsborough, to act in conjunction with the chairman and managing director, Mr. H. D. Marshall. He is also a director of the Madeley Collieries, Limited, and has been President of the Patents and Trade Marks Committee of the International Chambers of Commerce.

Reports and Dividends.

Allen-Liversidge, Limited.—Preference dividend at the rate of 6½ per cent. per annum for the six months ended October 31, 1929.

Steel Company of Scotland, Limited.—To general reserve, £12,500; to workmen's accident compensation reserve, £4,337; to depreciation, £3,000; carried forward, £118,844.

John I. Thornycroft & Company, Limited.—Net profit, £129,700; brought in, £55,182; final dividend of 5¼ per cent. on the participating preferred ordinary shares, making 9 per cent., and a dividend of 17½ per cent. on the ordinary shares; to reserve, £30,000; benevolent fund, £6,000; carried forward, £61,882.

Contracts Open.

Cairo, January 4.—Two Diesel engines and accessories, for the Ministry of Public Works, Mechanical and Electrical Department. The Department of Overseas Trade. (Reference A.X. 8,745.)

Cairo, January 6.—Centrifugal or turbine-type pumps, electric motors and filters, for the Egyptian Ministry of Public Works. The Department of Overseas Trade. (Reference A.X. 8,746.)

London, S.E., November 19.—Motor-driven stone-breaking plant, for the Director-General, India Store Department, Belvedere Road, Lambeth, London, S.E.1. (Fee 5s., non-returnable.)

Salford, November 25.—Electric travelling and slewing jib crane, for the Town Council. The City Electrical Engineer, Frederick Road, Salford.

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MANUFACTURERS & PRODUCERS OF REFRACTORY MATERIALS OF EVERY DESCRIPTION
BRICKMAKERS · QUARRY AND MINEOWNERS CONTRACTORS & EXPORTERS

GENERAL REFRACTORIES LIMITED

Incorporating
THE GENERAL REFRACTORIES CO., LTD. THE MIDLAND REFRACTORIES CO., LTD.
THOMAS BROOKE & SONS LTD. WORKSOP BRICK CO. LTD. GUISELEY SILICA CO. LTD.

Telegrams:
"GENEFRAX"
Sheffield
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BCM/GX
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KELHAM ISLAND MILLS SHEFFIELD · LOWGROUNDS BRICKWORKS WORKSOP · Notts. · BULLBRIDGE BRICKWORKS AMBERGATE · Derbys · GAYTON ROAD MILLS KINGS LYNN · THE BATTS MILLS WOLSINGHAM · Dur. · BRACKENHOOR FIRECLAY WORKS · STOCKSBRIDGE · LOUDOUN MILLS GALSTON · Ayrshire
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LONDON OFFICE 20 Budge Row E.C.4. (M° A.C. Turner)
Head Office Wicker Arches, SHEFFIELD
GLASGOW OFFICE 82 Dale St. C.5. (M° A.W. Montgomery)

Something *really* new in
CUPOLA LININGS

After many years of careful study of technical literature and the advertisements of our contemporaries, we have been driven to the conclusion that there are

TWO WEAK FACTORS IN ORDINARY BRICK LININGS
(1) THE JOINTS (2) THE BRICKS

We have destroyed the first bogey for ever by the introduction of "PYROLYTE" Fire Cement which sets cold harder than the bricks, and makes joints that after weeks of severe use of the cupola stand out beyond the brickwork because of their greater strength and infusibility.

[Sample cwt. in free steel drum 30/- delivered]

For some time now, we have been trying to solve the second problem by the production of a

"PYROLYTE BRICK"

which will possess the remarkable virtues of the fire cement combined with those additional qualities needed in a brick—We *think* we have succeeded but—

WE NOW NEED THE HELP OF HALF-A-DOZEN FOUNDRYMEN WHO WILL TRY OUT A RING OR TWO OF THE SAMPLE BRICKS WE WILL MAKE TO THEIR SIZE AND DELIVER TO THEM FREE IF THEY WILL KINDLY WRITE US WITH PARTICULARS.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—With a fairly consistent demand, and a more active inquiry on forward account, the position of the Cleveland iron market is at present somewhat obscured by apprehension of approaching troubles in the mining industry, which must almost inevitably result in increased fuel costs of production and consequently higher prices in the near future. Of course, if coal is to be dearer, cheaper iron and steel is out of the question, and consumers of foundry pig are now showing a little more freedom in placing orders. Many of them have been operating on very small reserves of iron, but, as there is now no special advantage in this hand-to-mouth policy, some consumers have been placing orders to cover their needs to the end of the year. It is in the home market that the contraction of business of late has been most pronounced, but as yet pig-iron manufacturers have experienced no serious difficulty in disposing of their output. Stocks are small, but makers would welcome forward contracts. Only a limited demand for Cleveland iron for export is reported, but October shipments amounted to 25,711 tons, as against 18,860 tons for September. Meanwhile prices remain stationary as follow:—No. 1 Cleveland foundry iron, 75s.; No. 3 Cleveland G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; No. 4 forge iron, 71s. per ton.

Although without change of importance, the market for East Coast hematite continues fairly satisfactory, and distinctly firmer, makers now having abandoned price-cutting tactics, at all events for the present. Quotations are irregular, but 78s. per ton is now generally regarded as a minimum figure for East Coast mixed numbers, and some of the makers are asking more. On the North-West Coast Bessemer mixed numbers are quoted at 77s. per ton at works.

LANCASHIRE.—The decision of the recent meeting of Midland ironmasters to make no change in prices was in accordance with general anticipations, although, at the same time, there is no question as to the firm state of the market. For delivery to local consumers' works Derbyshire and Staffordshire makes are both on offer at 77s. per ton. Scottish brands are still quoted for delivery at about 92s. 6d. to 93s. 6d. per ton.

THE MIDLANDS.—So far business in local markets has remained steady, if not active, the furnaces supplying this area being satisfied with the demands from the ironfounders ex contracts, and at the present time the tonnage being taken into consumption is good, while little, if any, stock is being accumulated by any of the Midland makers. Prices remain firm, with No. 3 Northants quoted at 75s., No. 3 Derbyshire at 78s. 6d., No. 3 North Staffordshire at 79s. 6d., and Scotch brands at 95s., all per ton, delivered local stations.

SCOTLAND.—In the market for Scottish iron the feeling is slightly brighter, but it cannot be said that there is much increase in the volume of business being done. Scotch pig-iron is in poor demand, but the price remains firm on the basis of 76s. per ton for No. 3 foundry, f.o.t. furnaces.

Finished Iron.

At Birmingham this week no improvement can be reported in the market for crown and the cheaper grades of manufactured iron. The Continental position prevents any expansion of trade in connection with nut and bolt iron. The foreign mills are quoting for their No. 3 iron in the region of £6 5s. delivered works in this district, whereas the cheapest local iron would be at £9 to £9 5s. There is not a great deal of business being placed at the moment even with the Continental works. With regard to crown iron, the local prices are from £9 15s. to £10 5s., but orders of any size are lacking. The makers of Staffordshire marked bars continue to be well occupied, and there is no difficulty in getting the figure of £12 10s. at works.

Steel.

Markets for steel and semi-products generally at the moment are experiencing a set-back from the ruling activity of an earlier period, and buying is now on a more restricted scale. Prices, however, of Continental semi-finished steel have shown a slight recovery, no doubt owing to the decision of the Continental Steel Cartel to reduce the permitted output of its members as from the beginning of the current month. Some heavy purchases of Continental semis have been made during the period of low prices, and this will affect the market for some time to come, as consumers, being well covered ahead, can afford to refrain from purchasing. Meanwhile few orders for semi-products are being placed with the British makers. In the tinplate market the tone is slightly easier, with prices at about 18s. 9d. basis for coke qualities, net cash, f.o.b. Welsh ports.

Scrap.

In the various markets for scrap metal for foundry purposes, though deliveries on current contracts are going through with fair regularity, inquiries on future account are by no means brisk, and are easily met by merchants. In the North-East Coast area, through all the changing circumstances of the past few months, ordinary quality cast-iron scrap has remained practically unaltered at 66s. per ton, and the foundries are still paying that figure, while good machinery quality in handy sizes continues to realise 68s. 6d. In the Midlands there is a good demand for all qualities of cast-iron scrap, 70s. to 72s. 6d. being offered for machinery cast iron, 65s. for heavy cast iron and 60s. for light cast-iron scrap. In Scotland the market for all classes of cast-iron scrap is still easy, and it is difficult to obtain many outlets for machinery quality even at 70s. Ordinary cast-iron scrap is at 65s., steelworks cast iron being also easy at around 61s. 3d. to 62s. 6d. Light cast iron is unchanged at 60s., with firebars at 57s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—During the past week markets for base metals in general have developed a marked decline in values, amounting, in the case of warrant copper, to a record low level for many years past, partially recovering at the close. The October statistical position is, however, expected to be favourable from a sellers' point of view, owing to the restriction of output which has been imposed. The future course of prices depends to a great extent on the policy of Copper Exporters, Inc., who in some quarters are expected to reduce the quotation for electro.

Closing quotations are :—

Cash.—Thursday, £68 5s. to £68 7s. 6d.; Friday, £68 2s. 6d. to £68 7s. 6d.; Monday, £69 2s. 6d. to £69 5s.; Tuesday, £67 to £67 2s. 6d.; Wednesday, £68 5s. to £68 10s.

Three Months.—Thursday, £68 7s. 6d. to £68 10s.; Friday, £68 3s. 9d. to £68 6s. 3d.; Monday, £68 13s. 9d. to £68 15s.; Tuesday, £67 2s. 6d. to £67 3s. 9d.; Wednesday, £68 5s. to £68 10s.

Tin.—Sharing the general depression, quotations for standard tin also touched the lowest point experienced for some five or six years, and the position remains weak. The statistics for October show an increase in the total visible supply of 1,432 tons, and the general outlook for the metal does not appear to be too bright. Some rather large sales are reported on the Continent, but inquiry from South Wales, in spite of low prices, is not particularly brisk.

Official closing prices :—

Cash.—Thursday, £178 15s. to £179; Friday, £178 5s. to £178 10s.; Monday, £175 10s. to £175 15s.; Tuesday, £174 15s. to £174 17s. 6d.; Wednesday, £175 10s. to £175 15s.

Three Months.—Thursday, £182 to £182 2s. 6d.; Friday, £181 10s. to £181 15s.; Monday, £178 10s. to £178 15s.; Tuesday, £178 to £178 5s.; Wednesday, £178 15s. to £179.

Spelter.—The market for zinc during last week was also affected by the general marking down of metal prices, declining to £20 12s. 6d., which is the lowest price recorded since £20 5s. was touched in 1913. During the war the price was as high as £115. In their current report, however, Messrs. Henry Gardner & Company, Limited, state that there does not appear to be any reason to anticipate any drastic changes in the present position in the immediate future.

Daily quotations are :—

Ordinary.—Thursday, £20 17s. 6d.; Friday, £20 12s. 6d.; Monday, £20 10s.; Tuesday, £20 10s.; Wednesday, £20 13s. 9d.

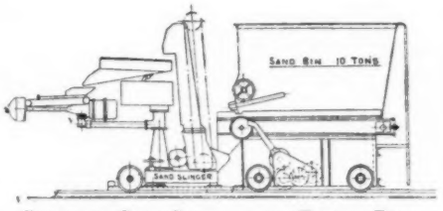
Lead.—In this section of the market also prices have experienced a weakening tendency, although on the whole the position of the metal is fairly well maintained. Consumers, although not too well covered, show little disposition to contract ahead. The position of this market is regarded as being fairly sound on the whole, and any considerable fall in prices is not expected.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £21 5s.; Friday, £21 15s.; Monday, £21 17s. 6d.; Tuesday, £21 15s.; Wednesday, £21 12s. 6d.

A Sand-Slinger Development.

The Foundry Plant & Machinery, Limited, of 100, Wellington Street, Glasgow, in order to ameliorate the working conditions of certain portable types of sand slingers, having developed a feeder tank truck, on which the slinger may be quickly mounted or dismounted. The feeder tank truck is fitted with a reversible electric motor controlled from the impeller head. The hopper, carrying about 10 tons of sand, is fed evenly



COMBINED SAND-SLINGER AND FEEDER BIN.

into the boot of the sand-slinger elevator, the quantity being readily controlled by a gate. The truck travels at crane speed on a 3-ft. rail track and where lay-out permits, it is desirable to lay this rail track across the foundry bays so that advantage can be taken of a maximum number of overhead cranes. This allows of the machine ramming on both sides of the track in two, three or more bays with corresponding advantage. Whilst accomplishing all this, the inherent elasticity of movement and action has been preserved by retaining an essentially portable machine.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Cupola Melting Ratios.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Some eight years ago, in a lecture to the members of the London Branch of the I.B.F., I introduced the suggestion that it was possible to melt iron satisfactorily with a much lower consumption of coke than was the general practice, and that I considered there must be hundreds of tons more coke used throughout the country than was really necessary. At the time I was very severely criticised, although I demonstrated the fact to a party of foundrymen. In THE FOUNDRY TRADE JOURNAL of November 7 I have read that a foundry in Scotland, melting from 80 to 100 tons per day, are doing so on a coke consumption of 6 per cent.

Perhaps my former critics will now sit up and take notice.—Yours, etc.,

J. J. MCCLELLAND,

"Druslyn," 81, Bishops Road,
Whitchurch, Glam.

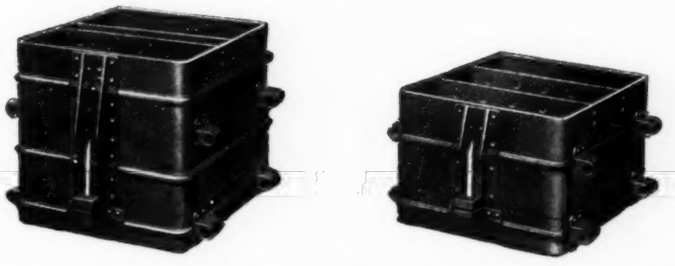
Sterling

MOULDING BOXES

WILL MAKE ENORMOUS SAVINGS WHERE CASTINGS ARE PRODUCED IN LARGE QUANTITIES.

They are ideal for all classes of moulding machines. They possess all the essential qualities necessary for rapid handling —Lightness; Rigidity; Durability; Permanent Accuracy; Freedom from Distortion and Freedom from Breakage.

All Sterling Boxes are made to specification and to suit the individual needs of each foundry. They are designed for use with either fixed or loose pins and we will drill them to suit your existing pattern plates.



STERLING BOXES FOR THE 12-TON STANDARD RAILWAY WAGON AXLE-BOX CASTINGS. WE HAVE MADE VERY LARGE QUANTITIES OF BOXES SIMILAR TO THE ABOVE FOR THIS PURPOSE.

We have a comprehensive range of standard styles of boxes covering every foundry service. Send your next moulding box enquiry to the leading moulding box manufacturers:—

STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1

BEDFORD.

Telephone: 3345 BEDFORD.
Telegrams: "STERFLASK, BEDFORD."
Code: WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	68	5	0
Three months	68	5	0
Electrolytic	81	10	0
Tough	73	0	0
Best selected	73	10	0
Sheets	110	0	0
India	91	0	0
Wire bars	83	10	0
Do. Dec.	83	10	0
Do. Jan.	83	10	0
Ingot bars	83	10	0
H.C. wire rods	85	10	0
Off. av. cash, October	72	17	2 17/23
Do., 3 mths., October	73	4	1 12/23
Do., Sttlmnt., October	72	17	6
Do., Electro, October	84	5	2 1/23
Do., B.S., October	77	15	10
Do., wire bars, October	84	10	10 10/23
Aver.spot price,copper,Oct.	72	17	2 17/23
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			11½d.

BRASS.

Solid drawn tubes	12¾d.
Brazed tubes	14½d.
Rods, drawn	12½d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	11½d.
Wire	10¾d.
Rolled metal	10½d.
Yellow metal rods	8d.
Do. 4 × 4 Squares	8½d.
Do. 4 × 3 Sheets	9d.

TIN.

	£	s.	d.
Standard cash	175	10	0
Three months	178	15	0
English	176	0	0
Bars	177	5	0
Straits	178	15	0
Australian	177	5	0
Eastern	180	12	6
Banca	185	15	0
Off. av. cash, October	190	17	7 7/23
Do., 3 mths, October	194	17	3 9/23
Do., Sttlmt., October	190	17	7 7/23
Aver. spot, October	190	17	7 7/23

SPELTER.

	£	s.	d.
Ordinary	20	13	9
Remelted	19	5	0
Hard	17	10	0
Electro 99.9	22	15	0
English	20	17	6
India	19	0	0
Zinc dust (Nom.)	31	0	0
Zinc ashes	7	0	0
Off. aver., October	23	2	6 15/23
Aver., spot, October	22	18	6 9/23

LEAD.

	£	s.	d.
Soft foreign ppt.	21	12	6
English	23	0	0
Off. average, October	23	4	9 9/23
Average spot, October	23	4	6 2/23

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	30	0	0
Do. V.M. ex-whf.	28	15	0
Rods	33	0	0
Boiler plates	26	10	0
Battery plates	27	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	48	15	0
Chinese	30	0	0
Crude	20	15	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	17	6
45/50%	11	10	0
75%	19	0	0
Ferro-vanadium—			
35/50%	12/10 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/2 lb. Mo.		
Ferro-titanium—			
23/25% carbonless	1/2 lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%, c. fr.	3/3½ lb.		
Tungsten metal powder—			
98/99%	3/6½ lb.		
Ferro-chrome—			
2/4% car.	£30	10	0
4/6% car.	£23	12	6
6/8% car.	£22	0	0
8/10% car.	£21	15	0
Ferro-chrome—			
Max. 2% car.	£33	5	0
Max. 1% car.	£38	0	0
Max. 0.70% car.	£39	15	0
70% carbonless	1/- lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/6 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/7 lb.		
Ferro-manganese (net)—			
76/80% loose	£13	10	0
76/80% packed	£14	10	0
76/80%, export	£14	0	0
Metallic manganese—			
94/96%, carbonless	1/6 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	3	12	6	to	3	15	0
Bundled steel and shrngs.	3	10	0	to	3	13	6
Mixed iron and steel					3	7	6
Heavy cast iron					3	0	0
Good machinery for foundries	3	2	6	to	3	5	0
Cleveland—							
Heavy steel					3	5	0
Steel turnings					2	17	6
Cast-iron borings					2	13	6
Heavy forge					3	15	0
W.I. piling scrap					3	10	0
Cast-iron scrap	3	6	0	to	3	8	6
Lancashire—							
Cast-iron scrap	3	2	6	to	3	10	0
Heavy wrought					4	0	0
Steel turnings					2	17	6
Scotland—							
Heavy steel					3	12	6
Cast-iron borings					2	15	0
Wrought-iron piling					3	18	0
Heavy machinery					3	10	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	62	0	0
Brass	43	0	0
Lead (less usual draft)	19	0	0
Tea lead	16	10	0
Zinc	14	10	0
New aluminium cuttings	68	0	0
Braziery copper	57	0	0
Gunmetal	57	0	0
Hollow pewter	140	0	0
Shaped black pewter	100	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	78/6
Hematite M/Nos.	78/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/-
,, d/d Birm.	93/6
Midlands—	
Staffs. common*	—
,, No. 4 forge*	75/6
,, No. 3 fdry.*	79/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	71/-
,, fdry. No. 3*	75/-
Derbyshire forge*	74/6
,, fdry. No. 3*	78/6
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	78/6
,, No. 3	76/-
Hem. M/Nos.	80/-
Sheffield (d/d district)—	
Derby forge	69/9
,, fdry. No. 3	73/6
Lincs. forge.	73/-
,, fdry No. 3	77/-
E.C. hematite	87/6
W.C. hematite	89/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	77/-
Northants foundry No. 3	—
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	93/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	93/-
Monkland, No. 3	93/-
Shotts, No. 3	93/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.) nom.					10	15	0
Nut and bolt iron	9	0	0	to	9	5	0
Hoops					11	0	0
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip					11	0	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	12	6	to	8	17	6
Boiler plts.	9	12	6	to	10	10	0
Chequer plts.					10	12	6
Angles					8	2	6
Tees					9	2	6
Joists					8	2	6
Rounds and squares, 3 in. to 5½ in.					9	2	6
Rounds under 3 in. to ⅜ in. (Untested)					8	2	6

and upwards

Flats—8 in. wide and over					8	7	6
,, under 8 in. and over 5 in.					8	12	6
Rails, heavy					8	10	0
Fishplates					12	10	0
Hoops (Staffs)					9	15	0
Black sheets, 24 g.					10	5	0
Galv.cor.shts.,24g.	12	17	6	to	3	2	6
Galv. fencing wire 8g. plain					12	0	0
Billets, soft	6	5	0	to	6	15	0
Billets, hard	7	10	0	to	8	0	0
Sheet bars					6	5	0
Tin bars					6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6
Rods	1/5
Tubes	1/9½
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bessemer billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.75
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd, No. 13	2.35
Wire nails	2.40
Plain wire	2.40
Barbed wire, galv.	3.05
Tinplates, 100-lb. box	$5.35

COKE (at ovens).

Welsh foundry	32/6 to 35/-
,, furnace	27/6 to 32/6
Durham and Northumberland—	
,, foundry	22/6
,, furnace	21/-
Midlands, foundry	—
,, furnace	21/6 and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box		18/9
,,	28×20 ,,		38/-
,,	20×10 ,,		27/6
,,	18¾×14 ,,		19/6
C.W.	20×14 ,,		16/-
,,	28×20 ,,		34/-
,,	20×10 ,,		22/7½
,,	18¾×14 ,,		16/-
Terneplates	28×20		33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ⅛ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	65%	47½%
Water	61½%	42½%
Steam	57½%	37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Nov. 7		68	5	0	inc.	42/6
„ 8		68	2	6	dec.	2/6
„ 11		69	2	6	inc.	20/–
„ 12		67	0	0	dec.	42/6
„ 13		68	5	0	inc.	25/–

Electrolytic Copper.

		£	s.	d.		
Nov. 7		82	0	0	No change	
„ 8		82	0	0	„	„
„ 11		81	10	0	dec.	10/–
„ 12		81	10	0	No change	
„ 13		81	10	0	„	„

Standard Tin (cash).

		£	s.	d.		
Nov. 7		178	15	0	inc.	50/–
„ 8		178	5	0	dec.	10/–
„ 11		175	10	0	„	55/–
„ 12		174	15	0	„	15/–
„ 13		175	10	0	inc.	15/–

Tin (English ingots).

		£	s.	d.		
Nov. 7		179	0	0	inc.	40/–
„ 8		179	0	0	No change	
„ 11		176	0	0	dec.	60/–
„ 12		175	5	0	„	15/–
„ 13		176	0	0	inc.	15/–

Zinc Sheets (English).

		£	s.	d.		
Nov. 7		30	10	0	No change	
„ 8		30	10	0	„	„
„ 11		30	0	0	dec.	10/–
„ 12		30	0	0	No change	
„ 13		30	0	0	„	„

Spelter (ordinary).

		£	s.	d.		
Nov. 7		20	17	6	dec.	7/6
„ 8		20	12	6	„	5/–
„ 11		20	10	0	„	2/6
„ 12		20	10	0	No change	
„ 13		20	13	9	inc.	3/9

Lead (English).

		£	s.	d.		
Nov. 7		23	0	0	dec.	15/–
„ 8		23	0	0	No change	
„ 11		22	15	0	dec.	5/–
„ 12		23	0	0	inc.	5/–
„ 13		23	0	0	No change	

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	4 15 0	4 17 6	5 0 0	5 0 0	5 0 0	4 17 6	4 17 6	4 17 6	4 17 6	5 0 0	5 7 6	5 7 6	4 19 9½
1897	5 7 6	5 7 6	5 7 6	5 5 0	5 0 0	5 0 0	5 2 6	5 2 6	5 2 6	5 2 6	5 0 0	5 5 0	5 3 5½
1898	5 5 0	5 5 0	5 5 0	5 7 6	5 13 9	5 15 0	5 15 0	5 15 0	5 17 6	6 0 0	6 5 0	6 7 6	5 14 3
1899	6 10 0	6 12 6	6 15 0	6 15 0	6 17 6	6 17 6	7 0 0	7 0 0	7 5 0	7 5 0	7 12 6	7 15 0	7 0 5
1900	7 15 0	8 0 0	8 2 6	8 5 0	8 5 0	8 7 6	8 7 6	8 2 6	8 2 6	8 0 0	7 10 0	7 10 0	8 0 7½
1901	6 15 0	6 12 6	6 5 0	6 0 0	6 0 0	5 10 0	5 15 0	5 17 6	6 0 0	5 17 6	5 17 6	5 15 0	6 0 5
1902	5 12 6	5 10 0	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 11 8
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 9
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 13 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 16 3
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	7 12 6	7 14 6	7 17 6	7 7 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 11 6	7 7 6	6 15 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	10 15 0	9 8 3½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6½
1919	11 2 6	13 12 6	13 12 6	13 12 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	19 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	10 0 0	10 0 0	10 0 0	9 8 9	9 9 6	9 10 0	9 8 9	9 11 6	9 18 9	9 11 8½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1½
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 2 6	7 3 4	7 2 6	7 3 9	7 7 6	7 8 5½	7 9 0	7 12 6	7 16 3	8 0 6	7 7 7½
1927	7 18 9	7 17 6	7 17 6	7 14 8½	7 13 9	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 14 1½
1928	7 12 6	7 14 9	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 16 10½
1929	7 17 6	7 17 6	7 17 6	7 17 6	8 0 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	—	—	—

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